United States Department of State

Bureau of Political-Military Affairs
Directorate of Defense Trade Controls

Washington, D.C. 20522-0112

In Reply Refer to
DTC Case TA 1883-03

Mr. Ron Alexander
Analex Corporation
5904 Richmond Highway, Suite 300
Alexandria, VA 22303

JUL 11

YOUR LETTER DATED: April 23, 2003
AGREEMENT FOR: Technical Assistance
FOREIGN LICENSEE: Bristol Aerospace Ltd—Canada
COMMODITY: Technical Data and Assistance Related to the Launch of SciSat-1 Satellite on Pegasus XL Space Launch Vehicle

Dear Mr. Alexander:

The Department of State approves the request as identified subject to the limitations, provisos or other requirements stated below. The agreement may not enter into force until these requirements have been satisfied. Any request for extension must be submitted to the Department for approval no later than 60 days prior to the authorized expiration date.

Sincerely yours,

for Peter J. Berry
Director, Office of Defense
Trade Controls Licensing

LIMITATIONS, PROVISOS AND OTHER REQUIREMENTS:

1. **This authorization expires December 31, 2006.**

2. If the agreement grants any rights to sublicense, prior to the release of any technical data, the sublicensee must execute a Non-Disclosure Agreement (NDA) incorporating all the provisions of the basic agreement which refer to the U.S. Government and the Department of State (i.e., 22 CFR 124.8 and/or 124.9). Copies of the executed NDAs, referencing this DTC case number, must be maintained by the applicant for five years from the expiration of the agreement.

3. No shipments of either hardware, software, technical data or defense services may take place against this agreement until such time as the agreement has been executed by all parties. In accordance with 22 CFR 124.4(a), a copy of the signed agreement, revised as may be required hereby, must be submitted to this office within 30 days from the date that it is signed. If a decision is made not to execute the approved agreement, you must so inform this office within 60 days.

In Reply Refer to
DTC Case TA 1883-03

4. If the agreement is not executed within one year of the date of this approval, a written report as to the status of the agreement must be submitted to this office on an annual basis until the requirements of 22 CFR 124.4 or 22 CFR 124.5 have been satisfied.

5. Shipment of hardware against this agreement under the provisions of 22 CFR 123.16(b)(1) or by separate license (i.e., DSP-5) is not authorized. Hardware shipment may take place only after the Department of State approves an amendment to the agreement.

6. This agreement MUST BE limited to provision of launch services as described in the application, with the following exception: because the on-orbit checkout role was not defined in either the Joint Mission Implementation Plan or the applicant's SOW, on-orbit checkout participation is NOT authorized.

7. The applicant MUST NOT release detailed design data or concepts, design methodology, or manufacturing know-how for the Pegasus launch vehicle, components, and ground support equipment. Technical procedures (to include the launch vehicle countdown procedure) that are launch vehicle specific are NOT authorized for release.

8. The applicant MUST NOT provide any technical assistance to the consignee(s) which might assist the consignee(s) in the design, development, or enhancement of contemplated or existing space systems, launch facilities, or launch processes/operations.

9. All anomaly/problem resolution MUST BE accomplished strictly by the responsible parties. Collaborative failure analysis with foreign parties is NOT authorized. Anomaly/non-conformance/failure reports MUST BE limited to functional block diagrams, top-level descriptions, and drawings/schematics that do not reveal detailed design. Data MUST NOT contain systems engineering processes, techniques, or methodologies.

10. Information on U.S. Government (USG) systems, operations, limitations, or capabilities that is NOT already in the public domain must NOT be offered, discussed, or released.

11. Launch failure analysis or investigation is NOT authorized under this license. In case of a launch failure, discussions or transfer of any technical data MUST BE the subject of a separate license submitted for department of state approval.

12. There MUST BE NO unmonitored or unescorted access to the launch vehicle or any controlled equipment or technical data related to the launch, unless otherwise authorized by a license. Whenever foreign nationals are present, monitoring MUST BE on a 24-hour basis by U.S. participants throughout launch preparations, satellite mating/demating, test and checkout, launch, and debris recovery.

In Reply Refer to
DTC Case TA 1883-03

13. The applicant MUST maintain a library of released technical data subject to USG inspection and audit. The cost of DOD participation in any audit performed by the USG is reimbursable to the DOD.

14. Applicant must provide NASA HQ, Code ID/Paula Geisz, 300 E. Street, SW, Washington, D.C. 20546, with a copy of this Department of State approval memo (license), and signed Technical Assistance Agreement.

15. NASA-controlled technical data listed in this TAA is approved for transfer. Transfer of other NASA non-public-domain technical data in support of this TAA requires NASA approval. Contact Ms. Paula Geisz for approval (phone: 202-358-1620, fax: 202-358-4080, e-mail: pgeisz@hq.nasa.gov).

LETTERHEAD

Director, Office of Defense Trade Controls Licensing March 31, 2003
U.S. Department of State
MD/DTCL, SA-1, 13th Floor
2401 E St., NW
Washington, DC 20037

Dear Mr. Maggi:

I, the undersigned, am a U.S. person as defined in 22 CFR 120.15 and I am a responsible official empowered by the applicant to certify the following in compliance with 22 CFR 126.13:

1. Neither the applicant, its chief executive officer, president, vice-presidents, other senior officers or officials (e.g., comptroller, treasurer, general counsel) nor any member of the board of directors is:

a. The subject of an indictment for or has been convicted of violating any of the U.S. criminal statutes enumerated in § 120.27 of this subchapter since the effective date of the Arms Export Control Act, Public Law 94329, 90 Stat. 729 (June 30, 1976); or

b. Ineligible to contract with, or to receive a license or other approval to import defense articles or defense services from, or to receive an export license or other approval from, any agency of the U.S. Government

2. To the best of the applicant's knowledge, no party to the export as defined in Section 126.7(e) has been convicted of violating any of the U.S. criminal statutes enumerated in 22 CFR 120.27 since the effective date of the Arms Export Control Act, Public Law 94329, 90 Stat. 729 (June 30, 1976), or is ineligible to contract with, or to receive a license or other approval to import defense articles or defense services from, or to receive an export license or other approval from any agency of the U.S. government, and

3. The natural person signing the application is a responsible official who has been empowered by the applicant and is a citizen of the United States.

I have enclosed an original and one (1) copy of an addendum sheet prepared in accordance with 22 CFR 126.13(b) listing the complete names and addresses of all U.S. consignors and freight forwarders and all foreign consignees and foreign intermediate consignees involved in the transaction.

Ron Alexander
Sr. Vice President/Chief Financial Officer
Analex Corporation
(703) 329-9400 x238

Consignors, Freight Forwarders, and Consignee.

U.S. Consignors:

Analex, Corporation
O&C, Rm. 2006
MC: Analex-1
Kennedy Space Center, FL 32899

Analex Corporation
Building 840, Rm. A102
Vandenberg AFB, CA 93437

Freight Forwarders:

FedEx World Service Center
2205 W Hwy 520
Cocoa, FL 32926

FedEx World Service Center
Airport Area
3070 Skyway Dr
Santa Maria, CA 93455

Sole Consignee:

Bristol Aerospace Limited
660 Berry Street
Winnipeg Manitoba,
Canada R3C 2S4

EXHIBIT 1

Technical Assistance Agreement (TAA)

Technical Assistance Agreement for SciSat 1

This agreement is entered into between Analex Corporation (Analex), an entity incorporated in the state of Delaware with offices at 5904 Richmond Highway, Suite 300, Alexandria, VA 22303 and Bristol Aerospace Limited (Bristol), a Canadian company with offices located at 680 Berry Street, P.O. Box 874, Winnipeg, Manitoba, Canada R3C 2S4 and is effective upon the date of the last party to sign the agreement.

WHEREAS Analex will provide technical assessment and mission qualification pre-launch services for Science Small Satellite 1 (SciSat 1) to Bristol under its Expendable Launch Vehicle Integrated Support (ELVIS) contract with NASA; and

WHEREAS Bristol will design, manufacture, produce, and assemble the SciSat 1 spacecraft;

NOW THEREFORE, the parties desire to enter into the Technical Assistance Agreement as follows:

1. The National Aeronautics and Space Administration (NASA) has negotiated a formal Memorandum of Understanding or MOU (ANNEX A) with the Canadian Space Agency that has the former agree to use its launch services contract to launch the Canadian-built SciSat 1; to support its operations once on orbit, checked out, and functioning; and to share the Earth science data that SciSat 1 will produce. The MOU calls for the signatories' centers and contractors to produce a detailed breakout of the tasks and responsibilities of the parties called a Joint Mission Implementation Plan or JMIP (ANNEX B) that shall be empowered by the MOU and have the force of an international agreement.

The Canadian Space Agency has contracted with Bristol Aerospace Limited, the SciSat 1 prime contractor, for the spacecraft and Bristol is integrating sensors and Canadian components for the Atmospheric Chemistry Experiment (ACE) sensors, a Fourier Transform Spectrometer (ACE-FTS) and MAESTRO, which stands for "Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation" described in Exhibit 2; communications; spacecraft orientation, navigation, and control systems; and on-board logistics and components.

NASA has contracted with Analex to provide the on-site payload-to-launch vehicle integration services under the ELVIS contract with NASA's Kennedy Space Center (which operates NASA's facilities at Vandenberg AFB, California.) Analex' role will be to provide on-site technical, security, and administrative support to launch services personnel and to assist in the technical preparation of the spacecraft at Vandenberg, which necessitates this agreement.

This Technical Assistance Agreement (TAA) is required so that Analex can carry out its responsibilities. Analex personnel will perform the work on site at Vandenberg AFB, California to get the launch vehicle and SciSat 1 payload integrated and ready for launch, and will then assist with on-orbit checkout and other tasks required of it by the JMIP and the ELVIS contract Statement of Work or SOW (ANNEX C).

Analex must be able to work closely with the U.S. launch services provider, Orbital Sciences Corporation (OSC), and with the Canadian payload contractor, Bristol. Analex' work with OSC and Bristol may involve any or all of the services, tasks, and technical data described in the JMIP and the ELVIS SOW. That is, Analex must be able to help integrate the spacecraft payload with the launch vehicle, assure its interfaces with ground systems are optimal, solve engineering and technical problems on the spot, and perform other, related work with Bristol at Vandenberg.

This TAA does not include Orbital Sciences Corporation, or Analex Corporation's subcontractor America Intellicom, Inc. (aka AISolutions). OSC has its own TAA with Bristol, AG 2104-00, Amendment 1, and the other firms will submit their own license or TAA applications if these prove to be necessary.

2. It is understood that this Technical Assistance Agreement is entered into as required under U.S. Government Regulations and as such, it is an independent agreement between the parties, the terms of which will prevail, notwithstanding any conflict or inconsistency that may be contained in other arrangements between the parties on the subject matter.

3. The parties agree to comply with all applicable sections of the International Traffic in Arms Regulations (ITAR) of the U.S. Department of State and that more particularly in accordance with such regulations the following conditions the following conditions apply to this agreement:

I. ITAR Section 124.7

(1) Analex will work with the Canadian SciSat 1 payload contractor, Bristol. Analex' work with Bristol may involve any or all of the services, tasks, and technical data described in the JMIP and the ELVIS SOW. That is, Analex must be able to help integrate the spacecraft payload with the launch vehicle, assure its interfaces with ground systems are optimal, solve engineering and technical problems on the spot, and perform other, related work with Bristol at Vandenberg.

(2) NASA has procured and will provide launch services on an OSC Pegasus XL-class vehicle and pre-launch engineering support. This includes providing data from the NASA's Total Irradiance Monitor (TIM) experiment, providing NASA engineering support for CSA spacecraft design and development (including mission design, associated Interface Control Documents or ICDs, payload processing and integration), identifying and implementing mission unique requirements, providing early orbit engineering support, and providing NASA oversight of SciSat 1 program as needed to satisfy requirements of the ICD. NASA and its contractors will jointly develop and verify ICDs on the interface between SciSat 1 and the launch vehicle. Analex will support NASA with payload integration and testing (I&T) services on the launcher.

All communication will be through and to the primary Spacecraft Point of Contact (S/C POC), the Spacecraft Project Manager, and the primary Launch Services POC, the NASA Launch Services Project Manager (MIM). Neither agency will interact with the other's contractors without prior approval of the other. Interaction between the agencies' contractors is permissible in order to expedite joint technical issues as appropriate.

Meetings and telecons will take place as necessary to maintain control of respective areas of responsibility, on an as required basis. As a general rule, no contractors will be in attendance without prior approval, on an as needed basis.

Working Groups will be conducted in accordance with the ELVIS contract.

Reviews and Launch Site Activities will be on an as required basis, and parties will be invited to attend as appropriate.

Technical interface will include ICDs, Contamination control plans, Launch Site Test Plan, Launch Site Procedures, etc., as per the JMIP and the list of documents at EXHIBIT 3. No hardware will be shipped under this agreement. If it becomes necessary for Analex to ship hardware to Bristol, a separate export license will be applied for.

(3) This TAA is to enter into effect on the date of the final signature and is remain in effect until Marc 3, 2006.

(4) Technical data will be shared with Bristol in Canada and with their employees in the U.S., mostly if not exclusively at Vandenberg Air Force Base, California and in its vicinity. Analex will deliver on-site support services to Bristol's Canadian personnel at Vandenberg or in its vicinity.

II. ITAR Section 124.8

(1) "This agreement shall not enter into force, and shall not be amended or extended without the prior written approval of the Department of State of the U.S. Government."

(2) "This agreement is subject to all United States laws and regulations relating to exports and to all administrative acts of the U.S. Government pursuant to such laws and regulations."

(3) "The parties to this agreement agree that the obligations contained in this agreement shall not affect the performance of any obligations created by prior contracts or subcontracts which the parties may have individually or collectively with the U.S. Government."

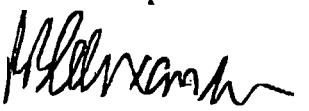
(4) "No liability will be incurred by or attributed to the U.S. Government in connection with any possible infringement or privately owned patent or proprietary rights, either domestic or foreign, by reason of the U.S. Government's approval of this agreement."

(5) "The technical data or defense service exported from the United States in furtherance of this agreement and any defense article which may be produced or manufactured from such technical data or defense service may not be transferred to a person in a third country or to a national of a third country except as specifically authorized in this agreement unless prior written approval of the Department of State has been obtained."

(6) "All provisions in this agreement which refer to the United States Government and the Department of State will remain binding on the parties after the termination of the agreement."

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed effective as of the day and year above provided.

Analex Corporation



Ronald B. Alexander

Senior Vice President – Chief Financial Officer

28 July 2003

(6) "All provisions in this agreement which refer to the United States Government and the Department of State will remain binding on the parties after the termination of the agreement."

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed effective as of the day and year above provided.

For: **Bristol Aerospace Limited**

By: _____
G.S. Lwedike

Title: Contracts Manager

Date: 25 July 2003

For: **Analex Corporation**

By: _____

Title: _____

Date: _____

ANNEX A

SciSat 1 Memorandum of Understanding (MOU)

Between NASA and CSA

Memorandum of Understanding

between the

National Aeronautics and Space Administration

of the United States of America

and the

Canadian Space Agency

Concerning the

SciSat-1 Atmospheric Chemistry Experiment (ACE) Mission

Table of Contents

Preamble

The National Aeronautics and Space Administration of the United States of America (hereinafter referred to as "NASA")

and

The Canadian Space Agency (hereinafter referred to as "CSA")

RECALLING the successful cooperation in the fields of space and Earth science;

DESIRING to extend the cooperation developed between NASA and CSA (hereinafter referred to as "the Parties"), and

CONSIDERING the Agreement for Enhanced Cooperation in Space between NASA and CSA of May 18, 1994 (hereinafter referred to as the "1994 Enhanced Cooperation Arrangement");

HAVE AGREED as follows:

Article 1 - Mission Description

Pursuant to the 1994 Enhanced Cooperation Arrangement, a joint study group has defined the science priorities and other details for specific cooperative projects of mutual interest involving NASA and the CSA science smallsat (SciSat) Program. This Memorandum of Understanding (MOU) addresses implementation of this first CSA SciSat-1 Atmospheric Chemistry Experiment (ACE) mission to be launched by a single NASA/U.S.-provided launch vehicle in 2002.

The objective of the ACE mission is to improve our understanding of the chemical processes involved in the depletion of the ozone layer, with particular emphasis on the processes occurring over Canada and the Arctic. This will be accomplished by analyzing and combining the measurements obtained from the space-borne ACE instrumentation with those obtained from ground-based, balloon-based and other space-based projects. In an effort to enhance ACE atmospheric chemistry research NASA will provide CSA with access to data from its Total Irradiance Mission (TIM). This TIM data will support atmospheric chemistry research by providing a better understanding of the Earth's radiation budget.

It is expected that this research will help determine future trends relating to the Earth's ozone layer, especially at high latitudes, and ascertain whether the springtime ozone depletion that is seen to some extent over the Arctic in late winter-early spring could reach the extent of that observed over Antarctica.

Article 2 - Responsibilities of NASA

NASA will use reasonable efforts to do the following:

1. Participate in the development of a Joint Mission Implementation Plan (JMIP), which addresses the equitable sharing of delivery capacity of the launch vehicle in mass, volume and orbit geometry, while ensuring the minimum science requirements of both Parties are met;

2. Procure and provide the equivalent of one-half of a Pegasus XL-class launch service provider and associated pre-launch engineering support as agreed to in the JMIP;

3. Provide data to CSA, from NASA's Total Irradiance Monitor (TIM) experiment currently scheduled for launch in mid-2002, as defined in the JMIP. This data, when available, will be provided to CSA for the duration of this MOU without restrictions and with a minimum of delay for release of calibrated data;

4. Provide, upon mutual agreement of both Parties, and on a reimbursable basis, NASA engineering support for the CSA spacecraft design and development;

5. Participate in CSA science mission reviews as agreed to in the JMIP;

6. Provide early orbit engineering support as agreed to in the JMIP; and

7. Provide the updates to the existing Stratospheric Aerosol and Gas Experiment (SAGE) and Atmospheric Trace Molecule Spectroscopy (ATMOS) algorithms and create a spectroscopic database for ACE.

Article 3 - Responsibilities of CSA

CSA will use reasonable efforts to do the following:

1. Participate in the development of a JMIP, which addresses the equitable sharing of delivery capacity of the launch vehicle in mass, volume and orbit geometry, while ensuring the minimum science requirements of both Parties are met;

2. Provide a Canadian satellite, conduct a scientific investigation, and arrange for scientific collaboration, as appropriate, for the mutual benefit of both Parties to this MOU;

3. Provide NASA with ACE science data freely and without restriction and with a minimum delay for release of calibrated data in accordance with Article 4 of this MOU;

4. Participate with NASA in the SciSat launch vehicle reviews as agreed to in the JMIP; and

5. Provide funding to NASA for costs of providing CSA-requested engineering support for the design and development of the CSA mission spacecraft.

Article 4 - Data Policy

The Parties will share science data without restriction and will specify in the JMIP the archiving and distribution policy for the data consistent with the policies of the Parties.

Results of the investigation will be made available to the general scientific community, through publication in appropriate journals or other established channels, as soon as possible and consistent with good scientific practices. In the event such reports or publications are copyrighted, NASA and CSA will have a royalty-free right under the copyright to reproduce, distribute, and use such copyrighted work for their own purposes.

Article 5 - Exchange of Technical Data and Goods

The Parties are obligated to transfer only those technical data (including software) and goods necessary to fulfill their respective responsibilities under this MOU, in accordance with the following provisions:

1. The transfer of technical data for the purpose of discharging the Parties' responsibilities with regard to interface, integration, and safety will normally be made without restriction, except as required by national laws and regulations relating to export control or the control of classified data. If design, manufacturing, and processing data and associate software, which is proprietary but not export controlled, is necessary for interface, integration, or safety purposes, the transfer will be made and the data and associated software will be appropriately marked. Nothing in this article requires the Parties to transfer goods or technical data contrary to national laws and regulations relating to export control or control of classified data.

2. All transfers of proprietary technical data and export-controlled goods and technical data are subject to the following provisions. In the event a Party finds it necessary to transfer goods which are subject to export control or technical data which is proprietary or subject to export controls, and for which protection is to be maintained, such goods will be specifically identified and such technical data will be marked with a notice to indicate that they will be used and disclosed by the receiving Party and its related entities (e.g., contractors and subcontractors) only for the purposes of fulfilling the receiving Party's responsibilities under the programs implemented by this agreement, and that the identified goods and marked technical data will not be disclosed or retransferred to any other entity without permission of the furnishing Party.

The receiving Party agrees to abide by the terms of the notice, and to protect any such identified goods and marked technical data from unauthorized use and disclosure, and also agrees to obtain these same obligations from its related entities prior to the transfer.

3. All goods, marked proprietary data, and marked or unmarked technical data subject to export control, which are transferred under this MOU, will be used by the receiving Party exclusively for the purposes of the programs implemented by this MOU.

Article 6 - Invention and Patent Rights

Nothing in this MOU will be construed as granting or implying any rights to, or interest in, patents owned or inventions of the Parties or their contractors or subcontractors.

In the event that an invention is jointly made by employees of the Parties, their contractors or subcontractors, during the implementation of this MOU, the Parties will consult and agree as to the responsibilities and costs of actions to be taken to establish and maintain patent protection for such invention and on the terms and conditions of any license or other rights to be exchanged or granted by or between the Parties.

Article 7 - Funding

Except as otherwise provided in this MOU, each Party will bear the costs of discharging its respective responsibilities under this MOU, including travel and subsistence of each Party's personnel and transportation of its own equipment and associated documentation. It is understood that the ability of the Parties to carry out their respective responsibilities is subject to their respective funding procedures and the availability of appropriated funds.

Article 8 - Customs and Taxes

In accordance with its laws and regulations, each Party will facilitate free customs clearance and waiver of all applicable customs duties and taxes for equipment and related goods necessary for the implementation of this MOU. In the event that any customs duties and taxes of any kind are nonetheless levied on such equipment and related goods, such customs duties or taxes will be borne by the Party of the country levying such customs duties or taxes. The Parties' obligation to ensure duty-free entry and exit of equipment and related goods is fully reciprocal.

Article 9 - Publication of Public Information and Results

NASA and CSA may release public information regarding their respective efforts in connection with this MOU. However, NASA and CSA each agree to coordinate in advance with the other any public information activities which relate to the other's responsibilities or performance. Information which has been previously cleared and has not changed will not require recoordination.

Article 10 - Liability

1. The purpose of this Article is to establish a cross-waiver of liability between the Parties and the Parties' related entities in the interest of encouraging space exploration and investment. The cross-waiver of liability will be broadly construed to achieve this objective.

2. For the purposes of this Article:

   (a) The term "Related Entity" means:

   (1) a contractor or subcontractor of a Party at any tier;
   (2) a user or customer of a Party at any tier; or
   (3) a contractor or subcontractor of a user or customer of a Party at any tier.

   The term "related entity" may also include another State or an agency or institution of another State, where such State, agency, or institution is an entity as described in (1) through (3) above.

   The terms "Contractors" and "Subcontractors" include suppliers of any kind.

   (b) The term "Damage" means:

   (1) bodily injury to, or other impairment of health of, or death of, any person;
   (2) damage to, loss of, or loss of use of any property;
   (3) loss of revenue or profits; or
   (4) other direct, indirect, or consequential damage.

   (c) The term "launch vehicle" means an object or any part thereof intended for launch, launched from Earth, or returning to Earth which carries payload or persons, or both.

   (d) The term "payload" means all property to be flown or used on or in a launch vehicle.

(e) The term "Protected Space Operations" means all activities pursuant to this MOU, including launch vehicle activities and payload activities on Earth, in outer space, or in transit between Earth and outer space. It includes, but is not limited to:

(1) research, design, development, test, manufacture, assembly, integration, operation, or use of launch or transfer vehicles, payloads, or instruments, as well as related support equipment and facilities and services;

(2) all activities related to ground support, test, training, simulation, or guidance and control equipment and related facilities or services.

The term "Protected Space Operations" excludes activities on Earth which are conducted on return from space to develop further a payload's product or process for use other than for the activity in question.

3. (a) Each Party agrees to a cross-waiver of liability pursuant to which each Party waives all claims against any of the entities or persons listed in subparagraphs (1) through (3) below based on damage arising out of Protected Space Operations. This cross-waiver will apply only if the person, entity, or property causing the damage is involved in Protected Space Operations and the person, entity, or property damaged is damaged by virtue of its involvement in Protected Space Operations. The cross-waiver will apply to any claims for damage, whatever the legal basis for such claims, (including negligence of every degree and kind), against:

(1) the other Party;
(2) a related entity of the other Party; and
(3) the employees of any of the entities identified in subparagraphs (1) and (2) above.

(b) In addition, each Party will extend the cross-waiver of liability as set forth in paragraph 3 (a) above to its own related entities by requiring them, by contract or otherwise, to agree to waive all claims against the entities or persons identified in subparagraphs 3 (a) (1) through 3 (a) (3) above.

(c) This cross-waiver of liability will be applicable to liability arising from the Convention on International Liability for Damage Caused by Space Objects, of March 29, 1972, where the person, entity, or property causing the damage is involved in Protected Space Operations and the person, entity, or property damaged is damaged by virtue of its involvement in Protected Space Operations.

(d) Notwithstanding the other provisions of this Article, this cross-waiver of liability will not be applicable to:

(1) claims between a Party and its own related entity or between its own related entities;
(2) claims made by a natural person, his/her estate, survivors, or subrogees for bodily injury, other impairment of health or death of such natural person, except where a subrogee is one of the Parties;
(3) claims for damage caused by willful misconduct;
(4) intellectual property claims;
(5) claims for damage resulting from a failure of the Parties to extend the cross-waiver of liability as set forth in paragraph 3 (b) or from a failure of the Parties to ensure that their related entities extend the cross-waiver of liability as set forth in paragraph 3 (b); or
(6) contract claims between the Parties based on the express contractual provisions.

(e) Nothing in this Article will be construed to create the basis for a claim or suit where none would otherwise exist.

Article 11 - Entry Into Force and Duration

This MOU will become effective upon signature and pursuant to an Exchange of Diplomatic Notes. It will remain in effect for five years after the ACE satellite has been launched, provided the Exchange of Notes remains in force. This MOU may be extended for an additional period of time by written agreement of the Parties.

Article 12 - Amendment

This MOU may be amended upon written concurrence of the Parties.

Article 13 - Termination

Either Party may terminate this MOU at any time upon at least 12 months written notice of the intent to terminate. Termination by either Party will not affect that Party's continuing obligations under this MOU with regards to liability and protection of data and goods. This MOU will also cease to have effect upon termination of the Exchange of Notes between the Government of the United States of America and the Government of Canada on the SciSat-1 Program (or the ACE Mission).

DONE in duplicate at Washington in the English and French languages, both texts being equally valid, this 24 day of October, 2000.

FOR THE CANADIAN SPACE AGENCY

W.M. (Mac) Evans
President

FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION OF THE UNITED STATES OF AMERICA

Daniel S. Goldin
Administrator

ANNEX B

CSA/NASA

SciSat 1 Joint Mission Implementation Plan (JMIP)

12 February 03

SCISAT-1

CSA/NASA

Joint Mission Implementation Plan

Approved By:

Feb 12/03

Glen Rumbold
CSA Program Manager

Approved By:

2-12-03

William R. Ochs
NASA Project Manager

Table of Contents

1 INTRODUCTION

The Canadian Space Agency (CSA) has elected to fly an Atmospheric Chemistry Experiment (ACE) on board a Canadian Small Scientific Satellite (SCISAT-1). The

primary instrument on board the spacecraft will be the Fourier Transform Spectrometer (FTS). The MAESTRO instrument will augment the science capabilities of the FTS.

Under an agreement with the National Aeronautics and Space Administration (NASA), the SCISAT-1 spacecraft will be launched by an air-launched Pegasus XL booster in 2003. This agreement requires that the CSA and NASA work together to achieve both a successful launch and spacecraft on-orbit operation that will accomplish the scientific objectives of the mission.

1.1 Purpose

The Joint Mission Implementation Plan (JMIP) further delineates the SCISAT-1 mission responsibilities for both NASA and CSA as defined in the "Memorandum of Understanding between the National Aeronautics and Space Administration (NASA) and the Canadian Space Agency Concerning the SCISAT-1 Atmospheric Chemistry Experiment (ACE) Mission". The JMIP also defines Mission Critical Milestones pertinent to the joint NASA/CSA activities, formal meetings/reviews, methods of conflict resolution between the two agencies, mission requirements pertinent to both agencies, technical deliverables between the agencies.

1.2 Scope

This document contains the mutually agreed plans of CSA and NASA for the implementation and delivery of the SCISAT-1 spacecraft to the launch site at Vandenberg Air Force Base (VAFB). It also governs the conduct of joint activities at VAFB to integrate the spacecraft to the launcher. It includes the methods and controls to be used to ensure the payload interfaces as required with the launch vehicle and that insertion into the specified orbit is achieved.

This document does not contain the specific CSA plans and procedures for the design and build of the SCISAT-1 spacecraft. Neither does it document NASA's plans for the provision of the Pegasus XL launch vehicle. It does outline the methods to be used to ensure NASA has sufficient visibility into the CSA program to establish that the spacecraft meets the launch vehicle requirements.

1.3 Documentation

1.3.1 Applicable Documents

The following documents govern the joint CSA/NASA activities associated with the Scisat-1 program and the content of this plan.

Memorandum of Understanding	
Joint Mission Implementation Plan	
ICD Between The SCISAT-1 And The Pegasus Launch Vehicle	Orbital Drawing A70410

1.3.2 Reference Documents

The following documents are for background only. The ICD will be the governing document for the interface between the spacecraft and the launch vehicle.

Mission Science Requirements	SCICSA-SP0005	Issue A, 9 Sept 99
Mission Requirements Document	SCICSA-SP0001	Issue B, 10 Sept 99
Spacecraft Requirements Document	SCICSA-SP0003	Issue C, 7 Feb 00

Ground Segment and Operations Requirements Document	SCICSA-SP0004	Issue N/C1, 15 Sept
Performance Assurance Guideline	SCICSA-ML0001	Issue A, 26 Oct 99
Instrument Requirements Document FTS	SCICSA-SP0002	Issue B, 17 Jan 01
Instrument Requirements Document MAESTRO	SCICSA-SP0009	Issue A, 5 Feb 01
Spacecraft AIT Plan	Bristol ER100337	Issue A
Spacecraft Bus Contamination Control Plan	Bristol ER 99117/A	Issue A, 5 June 01
SCISAT Mission Plan	NASA/KSC	April 16, 2002
Pegasus Users Guide	OSC	August 2000, Rel. 5.0

1.3.6 Document Change Procedure

The JMIP was developed jointly by CSA and NASA. The document is maintained by NASA, but cannot be changed without the consent of both CSA and NASA. Any required changes must be submitted in writing to both parties and agreed to prior to incorporation into the document.

2 SCISAT MISSION OVERVIEW

2.1 Science

The principal objective of the ACE mission is to measure and to understand the chemical and dynamical processes that control the distribution of ozone in the upper troposphere and stratosphere. The focus will be on one important and serious aspect of the atmospheric ozone problem - the decline of stratospheric ozone at northern mid-latitudes and in the Arctic. Specifically, the ACE Mission is to perform measurements whose data will be able to:

- Assess the complex environmental effects of chemicals. (Example: ozone)
- Understand the processes that control concentrations of chemicals. (Example: mechanisms for ozone depletion in mid-latitudes.)
- Quantify the export of pollution from individual countries and source regions. Example: movement of pollutants between Canada, US and Mexico, between Japan and China.
- Monitor the success of environmental policies. (Example: evaluate success of international agreements on chlorofluorocarbon (CFC) phase-out.)
  Discover the unexpected. Past examples: discovery of an Antarctic ozone hole, large scale pollution from tropical biomass burning.

2.2 Mission

The following describes the SCISAT-1/ACE mission, system elements, spacecraft bus, ACE-FTS instrument, MAESTRO instrument, ground segment and operations.

Anthropogenic changes in atmospheric ozone are increasing the amount of ultraviolet radiation received at northern mid-latitudes and in the Arctic, and may affect the climate. The SCISAT-1 mission will provide a comprehensive set of simultaneous measurements

of trace gases, thin clouds, aerosols and temperature will be made by solar occultation from low earth orbit, see Figure 2-2.

2.3 FTS Instrument

A high resolution infrared Fourier transform spectrometer (FTS) operating from 2 to 14 microns will measure the vertical distribution of trace gases as well as the meteorological variables of pressure and temperature. The instrument also has an auxiliary 2-channel visible / near infrared (IR) imager. During sunrise and sunset, the FTS measures infrared and visible absorption spectra that contain information on different atmospheric layers. These spectra will be inverted on the ground to provide vertical profiles (3-4 Km resolution) of atmospheric constituents. Temperature and pressure will be derived from

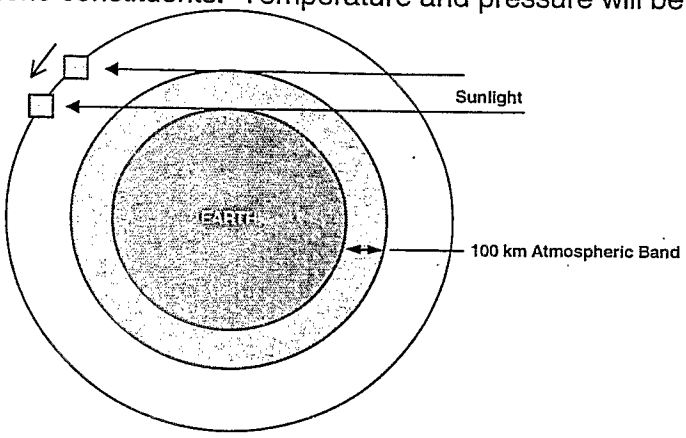


Figure 2-2 Mission Operations Scenario

the CO_2 lines. Aerosols and clouds will be monitored using the extinction of solar radiation at 1.02 and 0.525 microns as measured by two filtered CCD imagers and in the infrared by the Fourier transform spectrometer. The instrument includes a sun tracker, which provides the sun radiance to both the infrared spectrometer and the visible / near IR imager during solar occultation of the earth's atmosphere.

2.3.1. Fourier Transform Spectrometer

The infrared spectrometer is a high-resolution (0.025 cm^{-1}) infrared Fourier-transform spectrometer. It is an adapted version of the classical sweeping Michelson interferometer, using an optimized optical layout. The spectrometer will look at the sun through the atmosphere. From these spectra, the vertical distribution of trace gases and temperature will be extracted.

Double-sided interferograms will be Fourier-transformed on the ground in order to obtain the desired spectra. The IR spectrometer operates from 700 to 4100 cm^{-1} (2 to 14 μm) over 2 bands. Indium Antimonide (InSb) and Mercury-Cadmium-Telluride (HgCdTe or MCT) detectors are used in a special configuration. In order to operate under background limited conditions, both detectors must be cooled. However, the InSb has the more stringent requirements and need to operate below 110 K. Cooling of the detector package will be accomplished using a passive (radiative) cooler.

The spectrometer will be designed to achieve a signal-to-noise ratio better than 100 with a field-of-view (FOV) of 1.25 mrad and an aperture diameter of 100 mm, each measurement lasting for 2 seconds. A semiconductor laser will be used as the metrology source.

2.3.2 Visible/Near Infrared Imager

Aerosols will be monitored using the extinction of solar radiation. A 2-channel visible / near IR imager (VNI) provides sun images in two distinct spectral bands: 0.525 and 1.02

μm. A specific interference filter limits each spectral band. At low altitude, important refractive index changes in the atmosphere deflect the sunrays, thus moving the sun images relative to the instrument axis. To overcome this, each channel consists of a 128x128 effective photo detector array covering 60 mrad with a pixel separation of 0.50 mrad. This instantaneous FOV is 2 times smaller than the FTS FOV. These measurements will be done with a signal-to-noise ratio of 1000 for all sun-illuminated pixels for a 2-second observation time.

2.3.3 Sun tracker

An important subsystem of the instrument is the sun tracker, which provides the field-of-view tracking of the sun. It will autonomously keep the instrument looking at the sun radiometric center within an accuracy of 1 mrad. The sun tracker is a mirror mounted on a gimbal whose elevation and azimuth are controlled by balancing the signals from a quadrant detector.

2.4 MAESTRO Instrument

MAESTRO is a secondary instrument on the SCISAT-1 mission whose purpose is to augment the science obtained from the FTS.

The primary scientific goal to be achieved by adding the MAESTRO instrument as a payload element of SCISAT-1, is the provision of wavelength-dependent, atmospheric extinction data in the wavelength range 285 to 1030 nm with moderately high resolution (1 nm) and to provide ozone concentration profiles with higher precision (3%), vertical resolution (1km) and greater altitude coverage (10-80km) than the FTS data can provide.

The instrument will also have the capability of observing light scattered upward from the atmosphere below the satellite. This requires the ability to point the viewing direction toward the earth during daylight periods and to prevent the introduction of significant radiation from the sun into the instrument optics. Backscatter observations permit the mapping of ozone and other constituents during the daylight portion of the satellite orbit.

The MAESTRO instrument consists of a pair of grating spectrometers using array detectors. The instrument will make measurements contemporaneous with the FTS instrument at sunrise and sunset as well as measurements of backscattered solar radiation from the sunlit side of the planet.

The MAESTRO spectrometers will share the optical input and sun tracker with the FTS instrument.

2.5 Spacecraft

The SCISAT-1 spacecraft will comprise the functional blocks as shown in Figure 2-5 below. Each block identifies the associated major components. The spacecraft will employ a single spacecraft string architecture with a reliability goal of 0.8 over the two-year mission lifetime. The spacecraft layout is shown in Figures 2-5(a) and 2-5(b) that follow. The layout shows the FTS instrument and a simple box for the MAESTRO instrument. The FTS instrument is mounted such that its field of view is pointed along the spacecraft's +X-axis. The MAESTRO instrument will have a similar field of view and pointing requirement. The spacecraft maintains this axis constantly pointed at the sun, and is configured to have the major moment of inertia axis aligned with the sun vector for optimal stability. The solar array is fixed in position and supported by struts that provide some thermal isolation of the array from the main structural plate.

The array also serves as a mount for a fine sun sensor and one of the 6 coarse sun

sensor elements. The instruments and the balance of the bus components mount to the main structural plate and are covered on the upper surface with multi-layer insulation (MLI) blanket for thermal isolation from the 4°K temperature of space. The current mass budget should allow for a conservative, non-optimized structure design that is both low-cost and low-risk. Emphasis will be placed on structure design with conservative safety factors, high stiffness and natural frequencies that will prevent interaction with the launch vehicle or lower spacecraft structural modes. This approach is intended to reduce risk of major changes to the spacecraft later in the project due to instrument/component mass growth.

The spacecraft will utilize a passive thermal design, supplemented with heaters.

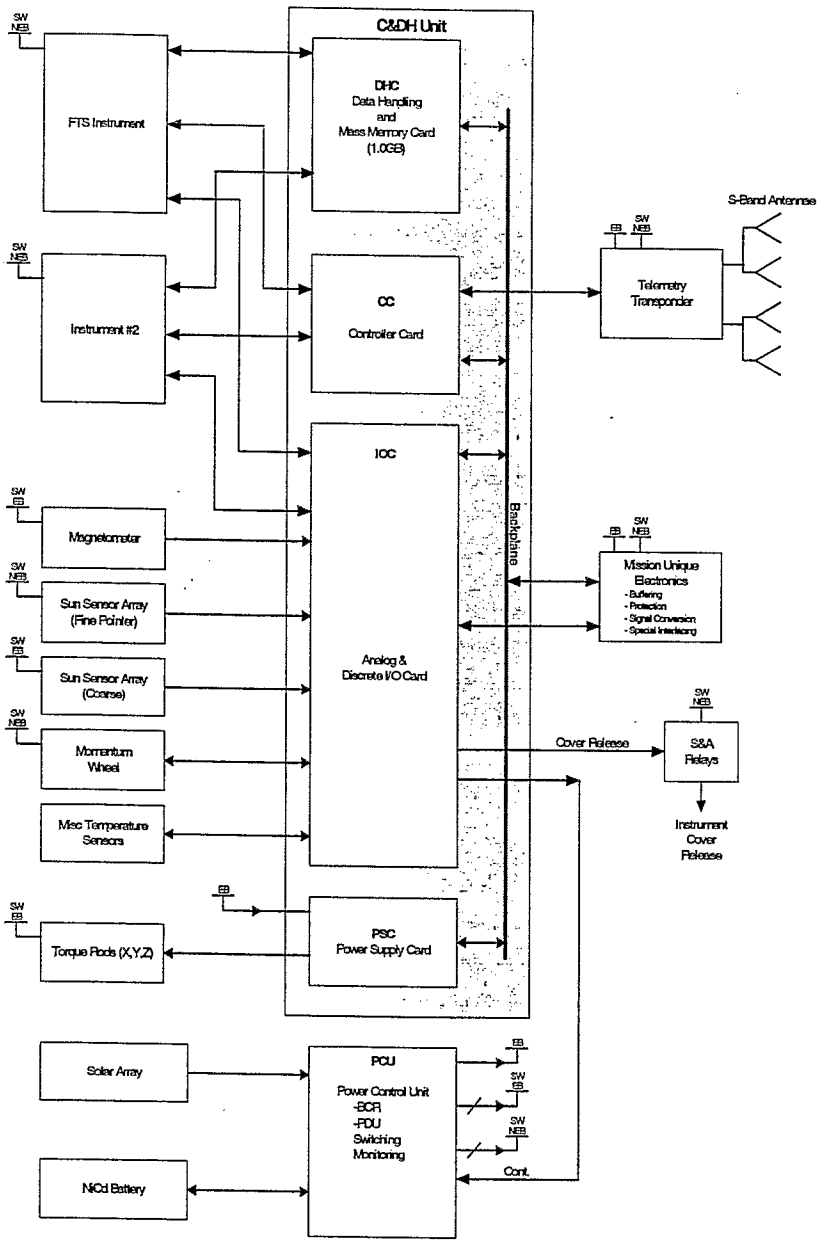


Figure 2-5 Spacecraft Block Diagram

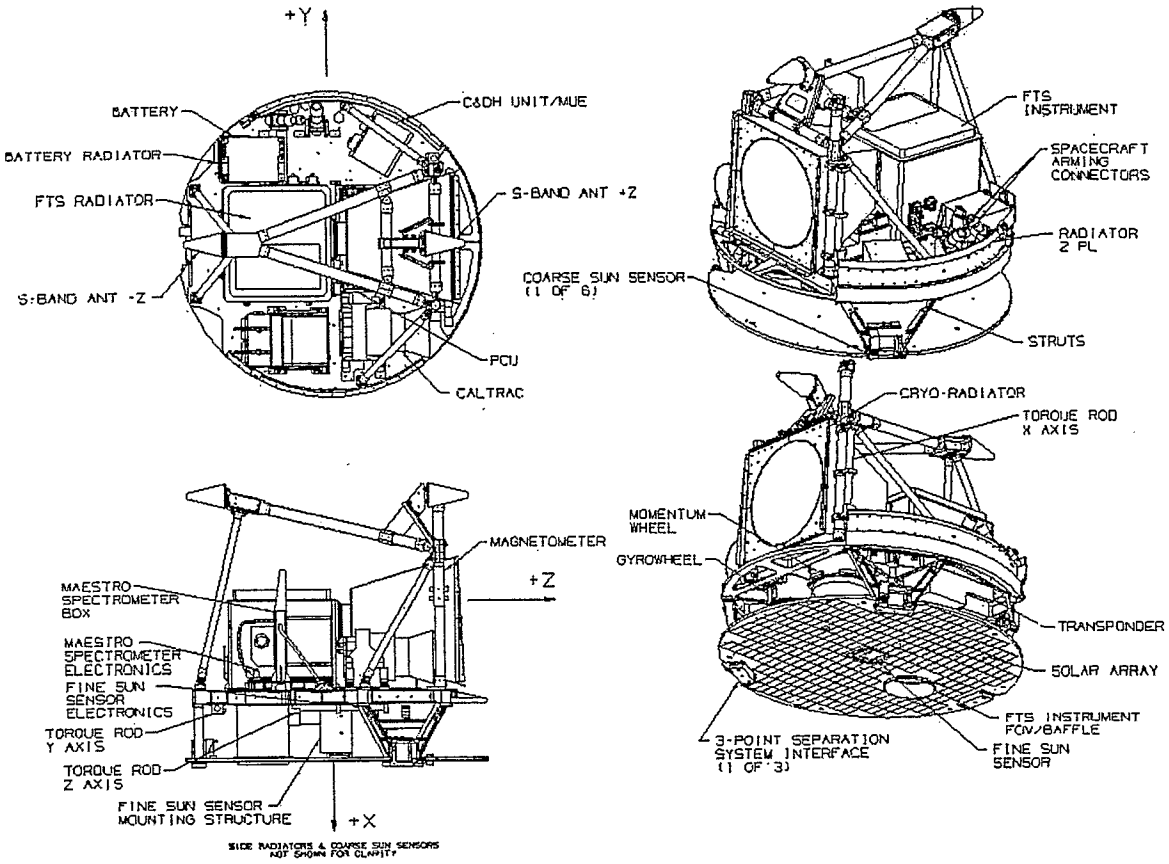


Figure 2-5(a) Spacecraft Configuration

The satellite will be sun pointing and power will be generated by a single body mounted solar panel. Power will be stored in a single lithium-ion battery.

The ADCS (Attitude Determination and Control System) configuration is based on a bias momentum stabilization approach. The subsystem consists of a momentum wheel, torque rods along all three body fixed axes, one fine sun sensor, a magnetometer and a set of six coarse sun sensors. All sensors and actuators are off-the-shelf components with flight heritage.

The ADCS operation consists of three main phases: capture, science and safe-hold. The capture phase starts after separation of the spacecraft from the launch vehicle. In this phase, the ADCS will align the spacecraft to a sun-pointing configuration using the torque rods, magnetometer and coarse sun sensors. During the science mode, the ADCS will maintain the sun-pointing orientation and satisfy the science pointing and stability requirements. During emergency situations, the spacecraft will be placed in a safe-hold mode. The safe-hold mode can be entered from other ADCS modes by an autonomous on-board algorithm. All other ADCS mode changes will be performed by ground command.

In keeping with the low cost approach for the satellite development, the flight software will implement minimal decision-making by deferring control to the ground operations. Communications and Tracking will be implemented through use of a NASA STDN (Satellite Tracking and Data Network) compatible transponder. The Communications

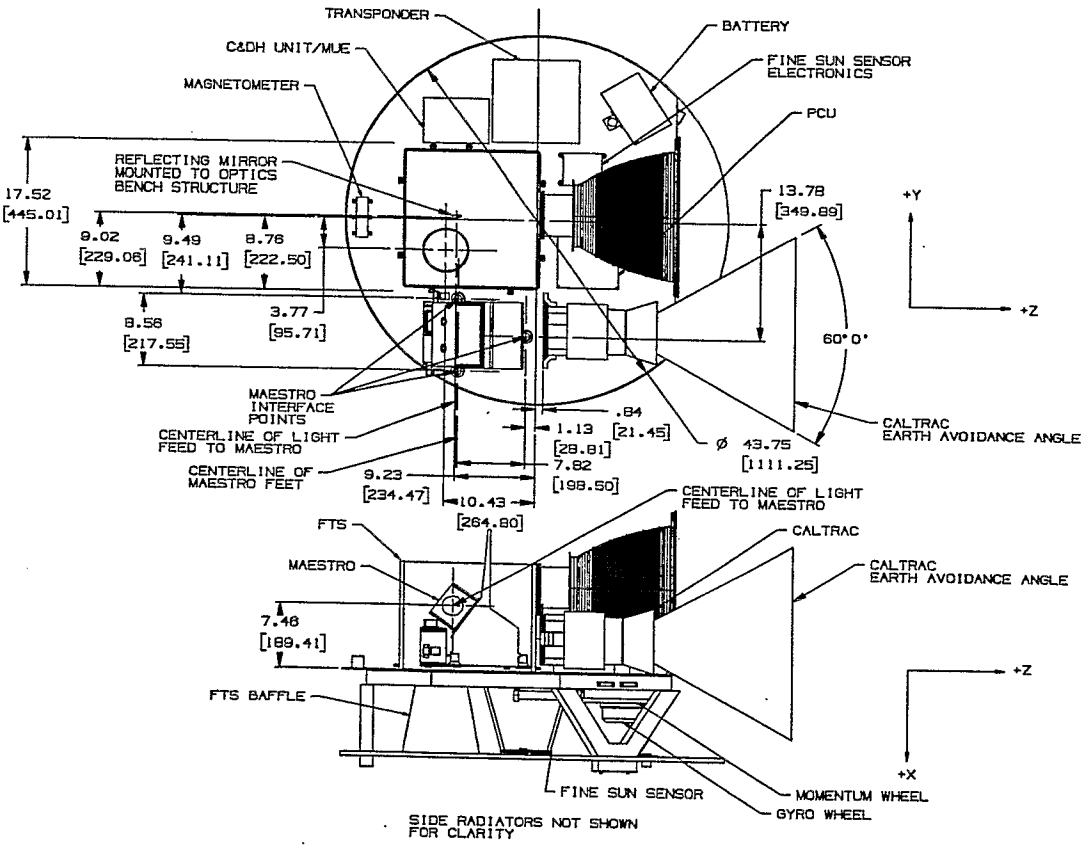


Figure 2-5(b) – Spacecraft Configuration

function is accomplished via a single S-band uplink and a single S-band downlink. The Tracking function is accomplished through ground station Doppler measurements with the transponder operated in coherent mode.

2.6 Launch Vehicle

The SCISAT-1 spacecraft will be launched on a Pegasus XL launch vehicle from the Vandenberg Air Force Base in California in 2003. Figure 4-4 below shows the SCISAT-1 spacecraft in the Pegasus fairing.

The launch vehicle requirements are specified in the Spacecraft to Launch Vehicle Interface Control Document (ICD). These include items such as mass, volume, insertion error, launch environment, temperature, humidity and contamination control.

2.7 Orbit Selection

The selection of an appropriate orbit is critical for the ACE mission to achieve its science goals. The baseline orbit was chosen to be circular with an inclination of 74° and an altitude of 650km. This orbit provides coverage of tropical, mid-latitude and polar regions. The vertical resolution will be about 3-4 km from the cloud tops (or the boundary layer for clear scenes) up to about 100 km. Because reference spectra of the sun will be recorded outside the earth's atmosphere, ACE will be self-calibrating. The RAAN is dependent on the launch date. The RAAN for a launch date of Dec. 20, 2002 is 150°. The acceptable uncertainty on each value is the same as specified for the Pegasus XL launch vehicle.

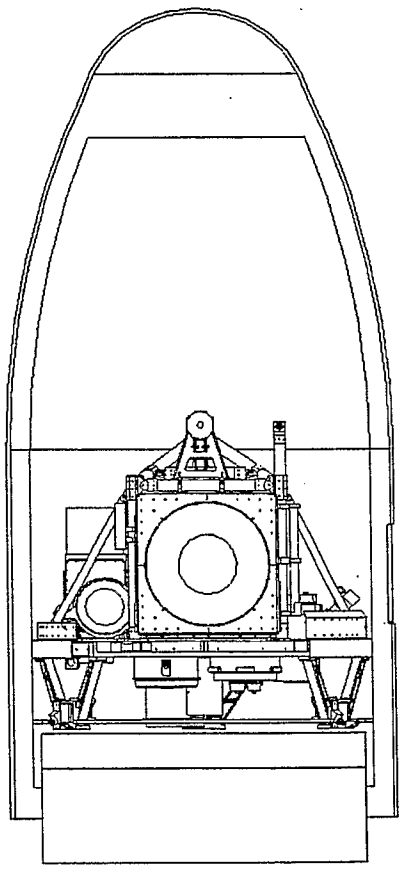


Figure 2-6 ACE in Pegasus Fairing

2.8 Ground Segment

The ground segment is the responsibility of CSA. It will consist of a Mission Management Office (MMO), a Science Operations Center (SOC), a Mission Operations Center (MOC) and additional Telemetry, Tracking and Command (TT&C) station(s) as may be needed for non-nominal operations. The interfaces between the ground segment facilities and the spacecraft are also the responsibility of CSA.

The MMO will manage overall mission requirements and priorities. It will be located in the CSA Space Science offices in Ottawa.

The SOC will be led by the Mission Scientist who will be responsible for all scientific aspects of the mission. It will be located at the University of Waterloo.

The MOC will provide ground control services and acquire science data from the spacecraft throughout the mission. The MOC will be located in the St. Hubert facilities of the CSA.

3 RESPONSIBILITIES

3.1 General

In general, CSA is responsible for the management of all aspects of the SCISAT-1 spacecraft program and NASA is responsible for the management of its launch vehicle program. CSA and NASA are jointly responsible for ensuring that the spacecraft and launch vehicle are compatible. This will be accomplished through the joint preparation of the ICD Between SCISAT-1 And The Pegasus Launch Vehicle as outlined below. NASA will be permitted oversight of the CSA SCISAT-1 program as needed to satisfy themselves that the spacecraft will meet the requirements of the ICD. CSA will provide

to NASA the documentation necessary to enable NASA to successfully launch the SCISAT-1 spacecraft. Specific joint and individual responsibilities are outlined below.

3.2 NASA Responsibilities

NASA will support the SCISAT-1 program as follows:

- Provide launch vehicle services for SCISAT-1
- Provide a Pegasus XL launch vehicle
- Provide engineering support associated with launch services including mission design, associated ICDs, payload processing, and integration
- Identify and implement mission unique requirements
- Provide a launch site (Vandenberg Air Force Base)
- Provide launch site services
- Provide engineering support for the SCISAT-1 spacecraft design and development on an agreed to schedule and cost reimbursable basis

3.3 CSA Responsibilities

The CSA is responsible for the following:

- Design, build, test and deliver the SCISAT-1 satellite (S/C) to Vandenberg for launch
- Ensure that SCISAT-1 has been fully tested to the environmental conditions determined by the chosen launch vehicle
- Verify that the resource allocations for SCISAT-1 have been met
- Provide requirements to NASA for wiring from launch vehicle to SCISAT-1 for vehicle checkout (Are the changes I made correct, didn't understand other wording)
- Provide NASA with SCISAT-1 information needed by Launch provider for launch vehicle/spacecraft ICD.
- Carry out analyses to ensure that SCISAT-1 will not see vibrations/loads higher than those predicted for the launch vehicle. If they are higher, modify the test plan to reflect the higher levels (this bullet was combined with the bullet above in the last version, but I think it should be separate)
- Specify SCISAT-1 requirements for Launch operations eg. cleanliness, gases, GSE equipment bench space and power, lifting devices, etc
- Provide launch and post-launch ops personnel support
- Provide NASA with regularly updated mass/CofG data and schedule updates

3.4 Joint Responsibilities

- Develop a Joint Management Implementation Plan
- Develop and verify the ICD Between SCISAT-1 And The Pegasus Launch Vehicle
- Support payload I & T on the launcher
- Agree on a dispute handling mechanism
- Decide on points of contact: CSA, NASA, Launch Provider, industry, scientists

3.5 Conflict Resolution

It is recognized that conflicts may arise as a result of interactions between the agencies as well as their industrial contractors. It is the intent that all conflicts/issues are resolved at the lowest level possible. In the event that a conflict/issue cannot be resolved at the initial level, it will be raised to the next appropriate level until it reaches the program management or executive level. If there is a conflict/issue or a resolution to a conflict/issue that involves budget or schedule it must be negotiated at the project management level.

For the purpose of conflict resolution the document hierarchy is:

- MOU Between NASA and CSA concerning SCISAT-1

- Joint Mission Integration Plan
- SCISAT-1 to Pegasus ICD

For any level of disagreement requiring resolution, the CSA and NASA representatives directly involved in the dispute will first attempt to resolve the conflict. If no resolution results, the matter will be elevated to the SCISAT-1 CSA/NASA GSFC program management level. If an agreement cannot be reached, the issue will be raised to the executive level. The points of contact for these levels of management are contained in 4.1 below.

If the conflict is technical, industrial contractor representatives will be brought into the discussions as deemed appropriate by both agencies.

4 COMMUNICATIONS

Communications between CSA, NASA and their contractors will be conducted in accordance with the following procedures.

4.1 Points of Contact

CSA SCISAT-1 Program Management Office will interact with NASA via the points of contact (POC) designated below. The CSA SCISAT-1 Project Manager or a designated representative will interface with the GSFC SCISAT-1 Project Manager on programmatic matters. The SCISAT-1 PM will also interface with the KSC Launch Vehicle Project Manager on all matters relating to the launch services including launcher/payload interface, launch site, launch activities, schedule, and cost. The GSFC SCISAT-1 PM's participation in CSA/KSC interactions will be at the PM's discretion.

Neither agency shall interact with the others contractors without the prior approval of the other. Interaction between the agencies contractors is permissible in order to expedite joint technical issues as appropriate. No agreement can be reached between the contractors which has the potential to change cost, schedule or technical requirements of the payload and/or launch vehicle or violates the terms and conditions of this plan.
All correspondence and official communications shall be between the points of contact designated below or their designated appointee.

CSA			NASA	
POC	Phone	Responsibility	POC	Phone
Roger Colley	613-990-0799	Executive	Rhoda Hornstein(HDQS)	202-3358-4805
"		International	DeVon Carrol(HDQS)	202-358-1622
Glen Rumbold	613-990-0803	Program Mgmt	Bill Ochs(GSFC)	301-286-2875
Tom Darlington	613-990-0783	S/C & L/V Proj. Mgmt	Cheryle Mako(KSC)	321-476-3691
Marie Yelle- Whitwam	613-596-1501	Launch Site Support	Julie Schneringer (KSC @ VAFB)	805-605-3380

4.2 Meetings and Telecons

In general meetings and telecons will take place as both parties agree is necessary to maintain control of their respective areas of responsibility. Management and technical interchange meetings will as a rule follow a specific schedule. Telecons will take place on an as required basis.

4.2.1 Management Meetings

Management meetings will take place as required and alternate between Ottawa and Washington. The host agency will put forward the agenda for consideration by the visiting agency. As a general rule, these will be one day inter agency meetings and will

not require the attendance of contractors. Typically, the following items will be discussed:

- International agreements
- Programmatic issues
- Mission status
- Spacecraft status
- Spacecraft/Launcher interface
- Launch

Other items may be added to the agenda as required to manage the CSA/NASA joint program responsibilities.

4.2.2 Technical Meetings

A Mission Integration Working Group (MIWG), GOWG and LOWG will be conducted in accordance with the Small Expendable Launch Vehicle Services II (SELVS II) contract to discuss:

- Spacecraft to Launcher ICD
- Spacecraft/launcher technical interface issues
- Technical splinters will be held as a part of the meetings on an "as required" basis
- Technical Interchange Meetings (TIMs) will be held as required on specific technical subjects/problems
- Telecons on specific topics also will be held as required

4.2.3 NASA/CSA Reviews & Launch Site Activities

NASA and CSA will participate in all reviews conducted by either organization, which has been deemed appropriate by both parties or one party has invited another party to. Certain reviews conducted by either organization will require participation by the other organization in order to provide insight, readiness for spacecraft at the launch site, establishment of launch readiness, or SCISAT-1 to Pegasus ICD verification.

The following meetings will require attendance or participation by the other organization:

- CSA Reviews
    - SCISAT-1 Mission Readiness Review (MRR)

- NASA Reviews (These reviews may be tailored for Defense Services Information as required by the ITAR.) Tables 4.2.3-1 and 4.2.3-2 below define the NASA Reviews required prior to launch, the purpose of the review, when it is conducted, and who is required to attend.

Meeting Name	Purpose / Agenda	When	Attendees
The Launch Campaign The NASA/ELV launch campaign is the period defined beginning with Pre-Vehicle on Stand (Boeing), Systems Review (LMA) or L/V Mission Readiness Review (Orbital) at approximately 45 days and ending at launch. It is at this point in which the NASA Chief Engineer and NASA Launch Manager's increase their participation with the MIT through launch.			
11 Pre-Vehicle on Stand (Pre-VOS/Boeing) Systems Review (LMA) L/V Mission Readiness Review (Orbital) (TBD) Coleman Research Corp	Obtain concurrence to erect L/V on pad, or to continue with L/V processing at the field site. Review includes mission overview, mission analysis, vehicle hardware and software, status on the factory buildup and launch site schedule.	L- 30 to 60 days	Chaired by ELV Chief Engineer & NASA Launch Manager or designees. Participants: Launch Service Provider, KSC, and S/C Project
12 KSC Center Director L/V Launch Readiness Review (CD LVLRR) (Requirement: 8610.24A)	To certify readiness to proceed with S/C/L/V integration activities. Obtain Center Director's concurrence to proceed with processing of the L/V and S/C. Review mission integration, significant open action items, configuration, first flight items, significant hardware issues, schedule, tracking support, range support, public affairs, and constraints to launch.	Approx. L – 45 days	Chaired by KSC Center Director and Board. Presented by KSC ELV Project and other KSC service organizations to KSC senior management. Participants: KSC, HQ, S/C Project invited but not required.
13 S/C Mission Readiness Review (MRR)	S/C Project seeks approval from PMC to continue S/C processing toward the Flight Readiness Review (FRR). S/C team presents/dispositions any open items to management and review panel to gain approval for transport to launch site.	Approx. L-30 days Typically after the Pre-VOS/System. Review/L/V MRR and CD LVLRR. S/C hosts review prior to ship to launch site.	Chaired by Sponsoring NASA Center's Program Management Council (PMC) or designee (Appointed Board). Participants: KSC MIT, NASA HQ, and S/C Project.

Table 4.2.3-1 NASA Reviews

Meeting Name	Purpose / Agenda	When	Attendees
14 Integrated Mission Assurance Review (IMAR)	To asses, independently from the project/program, the satisfactory completion of all activities necessary to provide an acceptable level of confidence in mission success. The IMAR is used by Headquarters Code Q to independently assess mission preparation status, open work, technical and programmatic issues and concerns, corrective actions and the consolidated mission probability of success of the spacecraft and vehicle.	Approx. L - 30 days	Chaired by: Code Q Participants: Safety, Health and Independent Assessment (SHIA), S/C Project and ELV Project
15 Flight Readiness Review (FRR) (Requirement: 8610.24A)	Certify readiness to proceed with spacecraft and launch vehicle processing towards launch. Review closeout of readiness review action items, assembly, check out and anomalies of vehicle and spacecraft, tracking support, range support, open work, and launch constraints.	L –5 days	Chaired by NASA Launch Manager or designee. Participants: LSP, Range, KSC ELV Project, GSFC Networks (as required), Weather Officer, and Spacecraft Program Office, and NASA HQ.
16 Launch Management Coordination Meeting (LMCM)	Brief the launch day management team and familiarize them with all aspects of launch countdown.	L – 3 to 5 days (Sometimes two sessions, one at approx. L-30 days)	Chaired by NASA Launch Manager Participants: KSC Launch Team, Spacecraft Project, LSP Launch Team
17 Mission Dress Rehearsal	Familiarize the launch day team with the countdown and communication by performing a simulated launch.	L - 2 to 3 days (Sometimes two rehearsals within L-30 days)	LSP Launch Conductor and LSIM coordinate Rehearsal for entire launch team.
18 Launch Readiness Review (LRR) (Requirement: 8610.24A)	Authorize approval to proceed into launch countdown and signature of the Flight Certification Document. Review final Mission readiness and closeout all action items.	L – 1 day	Chaired by the NASA Launch Manager and Spacecraft Mission Director. Presented by LSP, Range, Weather Officer, and Public Affairs.

Table 4.2.3-2 NASA Reviews

4.2.4 Telecons

In general, both management and technical telecons will be conducted on an "as required" basis. Typically, monthly management telecons will be conducted between the NASA and CSA Project Managers to review progress. As a general rule, telecons between NASA and CSA contractors, and CSA and NASA contractors, will not take place. However, if such contact is dictated by urgent circumstances, it is incumbent upon the individual making the call to advise their agency point of contact as soon as possible following the call.

While it is necessary for agency launch vehicle and spacecraft level contractors to communicate directly at times, no agreement can be reached between the contractors which has the potential to change launcher/spacecraft cost, schedule or technical requirements or violates the terms and conditions of this plan. Contractors will be required to brief their respective agencies as soon as possible on any significant items relating to the telecons.

5 SCHEDULE

A mission level schedule will be prepared by CSA and provided to NASA. Updates will be prepared on an as required basis and these will be provided to NASA. The mission level schedule will include, at a top level, items such as the instruments and spacecraft development and test schedules and the Mission Operations Center (MOC) schedule. It will also indicate dates for key events such as PDRs, CDRs, TRRs, MRR, spacecraft delivery and launch.

5.1 Mission Critical Milestones

Mission critical milestones are those milestones which if missed can significantly impact the other party. These milestones include the following activities:

- Launch Vehicle Readiness
- SCISAT-1 Ship Date to Vandenburg Air Force Base
- Launch Readiness Date

Status of these milestones should be reported during monthly telecons.

5.1.1 Launch Date Change Procedure

Either party must be notified in writing of any change to Launch Readiness Date. In the event the launch vehicle is late the CSA Program Manager and the CSA SCISAT Project Manager will be notified. In the event SCISAT-1 will be late, the NASA/GSFC SCISAT Project Manager and the NASA/KSC Mission Integration Manager should be notified.

5.2 Launch Penalty Costs

Launch penalty costs are assessed as defined in the SELVS II contract between KSC and Orbital Sciences Corporation Launch Services Group. Responsibility for launch penalty costs (if required) will be negotiated between NASA HQ and CSA executive management.

6 TECHNICAL INTERFACE MANAGEMENT

6.1 Launch Vehicle Interface

SCISAT-1 requirements on the launch vehicle will be contained in the "Interface Control Document (ICD) Between The SCISAT-1 And The Pegasus Launch Vehicle". Approval of the ICD requires signatures from Orbital Science Corporation, NASA/KSC, Bristol Aerospace, and CSA.

6.2 Contamination

The SCISAT-1 spacecraft contamination control requirements are defined in the Bristol Aerospace document, ER 99117/A, SCISAT-1, Spacecraft Bus Contamination Control Plan, Issue A, 5 June 2001. Any spacecraft contamination requirements levied on the launch vehicle must be defined in the SCISAT-1 to Pegasus ICD, which is the governing document for the launch vehicle.

6.3 Payload processing, launch vehicle integration, and test

SCISAT-1 requirements for processing at the launch site, integration into the launch vehicle, and testing at the launch site are defined in the following documents:

- Payload Requirements Document (PRD)
- Launch Site Test Plan
- Launch Site Procedures
- Launch Site Support Plan (LSSP)

7. TECHNICAL DELIVERABLES

Deliverables defined in this section are required to define the interface between the SCISAT-1 spacecraft and the launch vehicle, support those engineering activities associated with launch services, and to facilitate communications between CSA and NASA. To insure appropriate configuration management of a document once it is delivered, any updates/changes must be submitted to either party prior to incorporation into the document.

7.1 CSA Deliverables

CSA deliverables to NASA include the provision of monthly updates to Mission Level and AIT schedules. Table 7.1-1 below defines those documents to be delivered by CSA to NASA KSC to support the launch services being provided by NASA. Due dates will be maintained at monthly telecons, MIWGs, GOWG, etc. and will not be updated in the JMIP.

Payload (P/L) Deliverable	Due Date	Purpose
P/L Questionnaire	ATP	Draft ICD
P/L Development Schedule Milestones	ATP	Mission Planning Schedule
Identify/Auth of Mission-Unique Services	L-20M	M/U Hardware Development
Detailed P/L Drawings or Electrical Model	L-20M	M/U Hardware Development ICD's
P/L Fairing Access Door Location Req'ts	L-20M	M/U Hardware Development
P/L Structural Model (p)	L-17.5M	CLA (p)
P/L ARAR Preliminary Inputs	L-18M	Safety Assessment
Mission Analysis Inputs (p)	L-15M	Preliminary Mission Analysis
Final P/L Thermal Model	L-15M	Coupled Thermal Analysis
P/L Mass Properties (Interim Update)	L-15M	Preliminary Mission Analysis, P/L Separation Analysis (p)
P/L PRD Inputs(Launch Site Requirements)	L-14M	PRD
P/L Launch Site Test Plan/ Schedule	L-12M	Safety Assessment, Field site Planning
P/L Launch Site Procedures (p) (S/C Stand Alone & Integrated S/C-L/V)	L-8M	Safety Assessment, Field site Planning
Mission Analysis Inputs (f)	L-6.5M	Final Mission Analysis
Final As-Weighed P/L Mass Props (f)	L-6.5M	Final Mission Analysis, Final Separation Analysis
Launch Site Support Plan Inputs	L-6M	Launch Site Support Plan
P/L Launch ORD Inputs	L-6M	Launch OR
Environmental Test Plan	Test Start – 9 wks	ICD Verification
Final, Correlated Finite Element P/L Model	L-6.5M	Final Coupled Loads Analysis
Final P/L MSPSP	L-4.5M	Safety Assessment
P/L Environmental Test Results	L-4M	ICD Verification
P/L Launch Site Test Procedures, Final (S/C Stand Alone & Integrated S/C-L/V)	L-3M	Safety Assessment, Field site Planning
Final Launch Window Constraints	L-3M	Mission Constraints, Launch Operations
P/L Launch Checklist / Mission Constraints	L-6W	Launch Checklist Mission Constraints Document
P/L Dress Rehearsal Requirements	L-5W	Dress Rehearsal Plan

Table 7.1-1 Payload Deliverables

Table 7.2-1 defines items deliverable from NASA to CSA.

NASA Deliverable	Due Date
Post-Launch State Vector	L-1 hr.
Coupled Loads Analysis – Preliminary	s/c input +10 wks
Coupled Loads Analysis – Final	s/c input +10 wks
Preliminary Mission Analysis	s/c input +16 wks
Final Mission Analysis	s/c input +16 wks
RF link and compatibility	L-6 wks
Post Launch Quick Look Analysis	L+5 days
FRR & LRR High Level Minutes	ASAP after rev. (typically 1 week)

All items may be tailored for Defense Services Information as required by the International Traffic in Arms Regulations (ITAR).

Table 7.2-1 NASA Deliverables

8. ACRONYMS AND ABBREVIATIONS

ACE	Atmospheric Chemistry Experiment
ADCS	Attitude Determination and Control System
AIT	Assembly, Integration, and Test
CCD	charged coupled device
CDR	Critical Design Review
CFC	chlorofluorocarbon
CSA	Canadian Space Agency
FOV	field-of-view
FTS	Fourier Transform Spectrometer
GOWG	Ground Operations Working Group
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HDQS	Headquarters
ICD	Interface Control Document
ITAR	International Traffic in Arms Regulations
IR	infrared
I&T	integration and test
JMIP	Joint Mission Implementation Plan
KSC	Kennedy Space Center
LOWG	Launch Operations Working Group
LSSP	Launch Site Support Plan
MAESTRO	Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation
MIWG	Mission Integration Working Group
MLI	multi-layer insulation
MMO	Mission Management Office
MOC	Mission Operations Center
MOU	Memorandum Of Understanding
NASA	National Aeronautics and Space Administration
OSC	Orbital Sciences Corporation
PDR	Preliminary Design Review
P/L	payload
POC	Point Of Contact
PRD	Payload Requirements Document
PSR	Pre-Ship Review
S/C	spacecraft
SCISAT	Scientific Satellite
SELVS	Small Expendable Launch Vehicle Services
SOC	Science Operations Center
STDN	Satellite Tracking and Data Network
TIM	Technical Interchange Meeting
TRR	Test Readiness Review
TT&C	Telemetry, Tracking, and Command
VAFB	Vandenburg Air Force Base
VNI	visible/near infrared

ANNEX C

NASA KSC / Analex Corporation

Expendable Launch Vehicle Integrated Services (ELVIS) Contract Statement of Work (SOW)

1.0 Safety

ANALEX shall perform systems safety assessments, procedure reviews, and operations surveillance of spacecraft contractor design, integration, and test activities to ensure the identification and assessment, and elimination, or control of hazards.

1.1 Systems Safety Assessments

ANALEX shall perform system safety assessment of mission unique design, integration, test activities, and launch preparations. ANALEX shall participate in the tailoring of applicable safety requirements. ANALEX shall review and provide assessment of Spacecraft and Expendable Launch Vehicle (ELV) Missile System Pre-launch Safety Packages (MSPSP) or equivalent documents, variance requests, and design changes.

1.2 Procedure Reviews

ANALEX shall review all integrated procedures classified as hazardous to ensure hazardous operations are identified and appropriate safety precautions are implemented. In both cases, ANALEX shall assess all non-hazardous procedures to ensure proper classification.

1.3 Safety Surveillance and Support of Operations

ANALEX shall perform safety surveillance and assessments of all hazardous operations for NASA and Non-NASA missions when processing takes place on NASA property or within a NASA facility. ANALEX shall perform safety surveillance of all NASA mission integration activities that are classified as hazardous and are being performed on Launch Service Provider (LSP) property or within a Launch Service Provider (LSP) facility.

1.4 Participation in Meetings, Reviews, and Working Groups

ANALEX shall participate in NASA, Launch Service Provider (LSP) and spacecraft contractor, meetings/reviews including, status meetings, Technical Interchange Meetings, Design Reviews, Phase Safety Reviews, Payload Safety Working Groups, and Ground Operation Working Groups for NASA missions and other processing operations in NASA's assigned facilities.

1.5 Safety Training

ANALEX shall develop and conduct safety training including all required facility access/safety training for all NASA customers, NASA transient/resident, and contractor personnel for each NASA mission.

1.6 Quality Surveillance of Launch Service Provider (LSP)

ANALEX shall provide surveillance at all manufacturing, processing, testing, and launch site locations. ANALEX shall participate in local reviews, meetings, pertinent tests and local site visits.

1.7 Design Reviews:

ANALEX shall participate in Preliminary Design Reviews (PDR), Critical Design Reviews (CDR), and Design Certification Reviews (DCR), Mission Unique Requirements Reviews (MURR), Mission Unique Preliminary Design Reviews (MUPDR), and Mission Unique Critical Design Reviews (MUCDR). ANALEX shall review and provide technical assessment of Design restrictions, limitations and known violations including system safety, hardware and software.

1.8 Production Reviews

ANALEX shall participate in Hardware Acceptance Reviews (HAR), Pedigree Reviews, Production Reviews, and Pre-Vehicle-On-Stand Reviews (Pre-VOS). ANALEX shall review and provide technical assessments on any build paper, test results, non-conformance reports, discrepancy history, failure analysis, waivers, deviations, and MRB's presented at reviews.

1.9 NASA Launch Readiness Reviews

ANALEX shall attend Pre-Launch Readiness reviews (LRR and FRR) and launch activities.

2.0 Launch Site Support Engineering

ANALEX shall work with the NASA Launch Site Integration Manager (LSIM) for all ground processing mission activities and provide launch site support documentation, launch site operational services, launch operations management support, and launch site administrative services. The NASA Launch Site Integration Manager (LSIM) is the primary interface and ANALEX is the secondary interface. ANALEX shall represent the NASA Launch Site Integration Manager (LSIM) position at meetings, teleconferences, design reviews, technical interchange and working group meetings when the NASA Launch Site Integration Manager (LSIM) cannot attend.

ANALEX shall be the point of contact (POC) between spacecraft projects and other organizations including the Eastern Range (ER) and the Western Range (WR), Government/Commercial Payload Processing Facility (PPF)s, and Launch Service Provider (LSP)s.

2.1 Launch Site Documentation Services

ANALEX shall provide launch site documentation services.

ANALEX shall gather all documentation requirements from the payload customers by direct communication and through attendance to spacecraft and Launch Service Provider (LSP) meetings. ANALEX shall travel to the meetings if not held locally possibly involving foreign travel. These meetings include, but are not limited to the following: Project Kick-Off Meeting, Preliminary Design Review, Critical Design Review, Mission Integration Working Group meetings and teleconferences, Ground Operations Working Group meetings and teleconferences, Technical Interchange meetings, Pre-Ship review meetings. Launch Site Readiness Review, Flight Readiness Review, Launch Readiness Review. ANALEX shall use the information gathered and provide documentation services.

2.2 Launch Site Support Plan (LSSP)

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Launch Site Support Plan (LSSP). ANALEX shall publish and distribute preliminary and baseline versions of the Launch Site Support Plan (LSSP) with revisions as necessary. ANALEX shall catalog and incorporate changes to the Launch Site Support Plan (LSSP) and conduct detailed reviews with the payload customer in order to refine the document.

2.3 Program Introduction (PI) document for the Range

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Program Introduction (PI) document and submit to the Range.

2.4 Program Requirements Document (PRD) for the Range

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Program Requirements Document (PRD) for the Range.

2.5 Spacecraft Mission Operations Requirements (OR) document for the Range

ANALEX shall provide input to the Launch Service Provider (LSP) in the writing of the mission Operations Requirements (OR) document for submittal to the Range. ANALEX shall use the Launch Site Support Plan (LSSP) and Program Requirements Document (PRD) as well as further input from the NASA Launch Site Integration Manager (LSIM) and the payload customer to define and develop specific spacecraft inputs for the Launch Service Provider (LSP)-developed mission Operations Requirements (OR). ANALEX shall work closely with the Launch Service Provider (LSP) writer of the Operations Requirements (OR) to input these requirements. ANALEX shall review draft and published copies of the Operations Requirements (OR) for correctness. ANALEX shall modify Operations Requirements (OR) input as required.

ANALEX shall prepare the spacecraft Operations Requirements (OR) document for payloads processed in NASA and commercial Payload Processing Facilities (PPF). ANALEX shall use the Launch Site Support Plan (LSSP) and Program Requirements Document (PRD) as well as further input from the NASA Launch Site Integration Manager (LSIM) and the payload customer to develop a spacecraft-specific spacecraft Operations Requirements (OR) for spacecraft processing support in a Payload Processing Facility (PPF). ANALEX shall modify the spacecraft-specific spacecraft Operations Requirements (OR) as required.

2.6 Safety Advisory Function

ANALEX shall review customer requirements and advise the payload customer in safety planning including, but not limited to the following areas of facility requirements and modifications: mechanical, electrical, communications, contamination control, office space, telephones, base access and security.

ANALEX shall provide safety advice to the payload customer for the preparation the Missile Systems Pre-Launch Safety Package (MSPSP).

2.7 Review of Launch Service Provider (LSP)/Range-Provided Documentation

ANALEX shall review the Launch Service Provider (LSP) spacecraft Interface Control Document (ICD) and spacecraft questionnaire for completeness and accuracy of spacecraft requirements. ANALEX shall submit comments to the Launch Service Provider (LSP) after concurrence with the NASA Launch Site Integration Manager (LSIM).

ANALEX shall review and provide comments to the NASA Launch Site Integration Manager (LSIM) on Range-authored support documentation to ensure the Range properly addresses all customer requirements. This documentation shall include, but not be limited to the following:

- Statement of Capability (SC), which is the Range response to the Program Introduction (for Vandenberg Air Force Base (VAFB) missions only)
- Program Support Plan (PSP), which is the Range response to the Program Requirements Document
- Operations Directive (OD), which is the Range response to the Operations Requirements Document

- Network Implementation Plan (NIP), which is the Range launch day communications implementation plan
- Integrated Communications Requirements Document (ICRD), which is a communications annex to the Operations Requirements (OR) document

2.8 Launch Site Integration Operational Services

ANALEX shall perform the operational support tasks in coordination with the NASA Launch Site Integration Manager (LSIM).

2.9 Payload Transportation

ANALEX shall coordinate security escorts, and coordinate support from US Customs, Immigration and Agriculture Department for foreign payloads.

2.10 Payload Operations in the Payload Processing Facility (PPF)

ANALEX shall coordinate the review of payload customer test plans and technical operational procedures and track their approval status.

ANALEX shall perform the following tasks for payload operations in the NASA Payload Processing Facility (PPF)s:

- Distribute keys/combinations
- Coordinate facility and safety training
- Coordinate shipping and receiving services
- Coordinate access lists and guard orders
- Maintain a spacecraft activities log book
- Coordinate the procurement and use of consumables, supplies and materials
- Coordinate and schedule support for fueling operations
- Coordinate delivery radiation sources with the USAF
- Coordinate storage of pyros and radiation sources
- Coordinate photo support from the USAF
- Be cognizant of payload activities and reschedule support in response to anomalies and changes in plans

2.11 Payload Operations at the Launch Complex

ANALEX shall coordinate movement of payload ground support equipment (GSE).

ANALEX shall coordinate all launch complex access requirements including, but not limited to training, badging, security escort services, and tours.

ANALEX shall coordinate contractor support for off-shift operations, monitor payload activities, and reschedule support in response to anomalies and changes in plans.

2.12 Post Launch

ANALEX shall coordinate GSE movement, monitor customer clean-up/close-out activities, and coordinate shipping services.

3.0 Launch Operations Management Services

ANALEX shall provide launch operations management services in coordination with the NASA Launch Site Integration Manager (LSIM).

ANALEX shall coordinate between the Launch Service Provider (LSP), NASA Launch Director, NASA Launch Site Integration Manager (LSIM), and payload customer to produce the Launch Management Coordination Meeting (LMCM) presentation package. The Launch Management Coordination Meeting (LMCM) package shall include, but not be limited to launch day management and reporting structure; launch day "GO/NO GO" charts; list of mandatory assets for launch; launch day seating charts; launch day voice communication charts; and range conflict calendar.

ANALEX shall coordinate and schedule launch countdown rehearsals for the payload customer in the weeks prior to launch.

ANALEX shall, in coordination with the external public affairs organization, create and implement a plan to provide voice communications, video, timing, satellite up-links and down-links, and Launch Site Support Trailer (LSST) for coverage of a launch. ANALEX shall participate in planning meetings and teleconferences.

4.0 Launch Site Administrative and Customer Services

ANALEX shall provide secretariat function services for all launch site integration activities to include, but not be limited to the following: develop meeting minutes/actions and publish/distribute preliminary and final versions, prepare agendas and security access lists, coordinate meet-me numbers for teleconferences, arrange facility accommodations and presentation equipment, reproduce meeting materials, and record attendance

4.1 Launch Site Customer Services

ANALEX shall conduct the Launch Site Introduction/Familiarization Briefing for the payload customers. ANALEX shall prepare the briefing material to include but not be limited to familiarization/introduction of the launch site, list of points of contact, local community and center/base accommodations/capabilities, and any specific information related to facilities/equipment.

5.0 Mission Integration Coordination Services

ANALEX shall participate in each Expendable Launch Vehicle (ELV) mission through active participation of the Mission Integration Teams (MIT).

5.1 Integrated Mission Data, Documentation, and Schedules

ANALEX shall prepare a mission plan for each mission immediately preceding the Authority To Proceed (ATP) for the Launch Service Provider (LSP). The mission plan shall be accessible to payload customers through a controlled website.

Using inputs from the NASA Mission Integration Team (MIT), ANALEX shall prepare and maintain an integrated mission schedule that shall be compatible with Milestones Professional scheduling software. ANALEX shall evaluate mission integration schedules to identify potential schedule conflicts and inform NASA.

ANALEX shall maintain and NASA Payload Planner's Guide using information provided by the MIM.

5.2 Administrative Services

ANALEX shall develop documentation packages (e.g. Risk sheets, Mission Integration Working Group (MIWG) presentations) for mission management and NASA Mission Integration Team (MIT) activities to include, but not be limited to meetings, briefings, reviews and other activities that are at the Agency, Program, Project, and NASA Mission Integration Team (MIT) levels.

5.3 Secretariat Functions

ANALEX shall provide secretariat function services for all NASA Mission Integration Team (MIT) reviews to include, but not be limited to the following: develop meeting minutes/actions and publish/distribute, prepare agendas, coordinate meet-me numbers for teleconferences, arrange facility

6.0 Launch Engineering Team (LET) Services

ANALEX shall provide technical services to the Launch Engineering Team (LET) formed to support NASA and NASA-sponsored Expendable Launch Vehicle (ELV) launches to include, but not be limited to the following:

- Document, organize, and track internal and external action items that are significant to the LET in preparation for readiness reviews during the launch campaign such as Pre-Vehicle-On-Stand (Pre-VOS) Reviews, Systems Reviews, Flight Readiness Reviews (FRR), Launch Readiness Reviews (LRR), and related technical readiness reviews.
- Coordinate Technical Interchange Meetings (TIM) to include participation from offsite engineering organizations. Document, organize, and track internal and external action items that are relevant to the LET.

7.0 Communications and Telemetry

ANALEX shall provide engineering, operations, and maintenance of NASA communications and telemetry systems in all operational areas for NASA supported Expendable Launch Vehicle (ELV) missions including commercial and other payload customers of the NASA Program.

ANALEX shall provide technical interchange with NASA to provide status and immediately communicate any significant issues.

ANALEX shall be responsible for the following communications and telemetry support activities while processing at NASA and/or Commercial Payload Processing Facility (PPF)s:

- Operation & Maintenance of Communications and Telemetry Systems
- Disposition Requirements
- Engineering and Planning
- Setup and Activation
- Configuration Control
- Maintenance
- Troubleshooting
- Breakdown and Stowage

ANALEX shall provide troubleshooting and platform services for Expendable Launch Vehicle (ELV) customers where required. ANALEX shall coordinate and schedule customer requirements. ANALEX shall create a customer interface for data services to adapt customer equipment to the facility transport where necessary.

ANALEX shall permit specific equipment to remain operational and un-attended during non-supported hours when requested by NASA. ANALEX shall report to NASA the risks associated with unattended operation of this equipment and shall take appropriate steps to mitigate these risks.

7.1 Communications Systems

Using Installation-Provided Property (IPP), ANALEX shall provide the following services to all NASA customers:

- Voice
- Video
- Data
- Timing

ANALEX shall request and schedule communications circuits and support from the responsible organizations to meet all requirements. ANALEX shall coordinate directly with these outside organizations to assist in the activation and troubleshooting of these assets. ANALEX shall field support equipment to outfit these communications circuits to satisfy customer requirements.

ANALEX shall provide real-time end-to-end testing and troubleshooting of all communication links. ANALEX shall provide communication services for the public affairs video and audio production and satellite uplink activities for all NASA sponsored missions. This shall include all required planning of external contractor video and audio productions and technical support to interface equipment with NASA communication and video circuits.

7.2 Telemetry Systems

ANALEX shall provide time-tagged reception, recording, processing, and display of all incoming telemetry data. Telemetry data shall consist of: FM/FM telemetry, PCM/FM telemetry and separate analog signals. This data shall arrive via hard-line, fixed RF antenna, NASA Integrated Services Network (NISN), Internet-protocol Operational Network (IONET), or modem. ANALEX shall provide playback telemetry data support including displays and strip-charts as required by NASA.

ANALEX shall plan, develop, maintain, and troubleshoot software on the telemetry processing systems as required.

ANALEX shall provide analog recording and reproduction of unprocessed telemetry data and timing. ANALEX shall make copies of these tapes as requested by NASA and deliver them to the appropriate destination. ANALEX shall create and maintain a set of paper strip-chart recordings for all major tests and launch attempts, and copies of these recording will be delivered to the appropriate destination.

7.3 Upcoming Launches Scheduling, Planning, and Status Reporting

ANALEX shall create, maintain, and implement an integrated schedule for all the services provided for each scheduled mission.

ANALEX shall provide implementation plans for meeting mission communications and telemetry requirements including design drawings, procurement documentation, resource allocation, agreements with external service providers, and detailed scheduling.

ANALEX shall participate in technical interchange meetings to provide status to NASA and to receive customer requirements. ANALEX shall also conduct facility and console familiarization presentations to NASA customers.

ANALEX shall participate in launch readiness reviews and briefings and provide presentations during these reviews on facility and equipment readiness status. ANALEX shall provide readiness reports to responsible critical activity review boards and status including testing results, training, certification, hardware and software status, and procedures. Prior to each Flight Readiness Review (FRR) scheduled 5 days before launch, ANALEX shall provide to NASA a detailed status of all equipment and resources required for the launch. This launch status briefing shall include but not be limited to:

- Configuration of all support equipment
- Version identification of all software
- Identification of all technical leads
- Any issues/concerns which may impact launch support
- Brief summary of any equipment, resources, or services which shall be used for the "first time" to support a launch
- Brief review of any problems which impacted the last launch and the actions taken as a result of these problems
- A formal declaration of the capability to support from ANALEX or sub-contractor

7.4 Technical Points of Contact (POC)

For each mission, ANALEX shall have a single point of contact in the following areas:

- Telemetry operations,
- Real-Time data processing,
- Communications,
- RF Systems operations,
- Mission Operations Director,
- Data Impound Coordinator

These POCs shall be responsible for the following:

- Providing NASA status on contractor support for the mission,
- Coordinating operation of the service during major tests and launch attempts for the mission,
- Provide the post launch briefing for services provided for the launch,
- Provide the problem report and resolution for issues and concerns that affected mission support.

7.5 Facilities, Facility Systems, and Support Equipment

ANALEX shall operate and provide routine maintenance of all Installation-Provided Property (IPP). ANALEX shall operate lifting equipment such as cranes and hoists and perform proof-load testing. When required, ANALEX shall proof-load payload customer equipment. ANALEX shall document results and provide NASA access to data related to maintenance records, troubleshooting efforts, problem causes, and corrective actions taken, proof-test certificates, operational and test procedures, and test data records in accordance with DRD-1, Access to Contract Data, Maintenance Records.

ANALEX shall provide electrician services to include, but not be limited to troubleshooting, reconfiguration, modification, and general maintenance of facility electrical systems.

7.6 Maintenance Management

ANALEX shall identify and document immediately upon discovery all real time problems related to mission-critical and safety-critical facilities, systems, and equipment. ANALEX shall coordinate resolution with all affected parties, including other contractors, to ensure effective responses and to provide mitigation.

ANALEX may be required to provide maintenance and repair in cases where the USAF Base Civil Engineering (BCE) services where the USAF support cannot be obtained in a prompt manner.

8.0 Base Operations Services

8.1 Administrative Support

ANALEX shall provide reproduction services and operation and maintenance of reproduction equipment.

ANALEX shall provide United States Postal Service and Vandenberg Air Force Base (VAFB) internal mail pickup and delivery.

ANALEX shall obtain photo and video services from the USAF 30th Visual Flight and provide coordination to satisfy NASA personnel, customer, and contractor photo and video requirements.

8.2 Graphics Services

ANALEX shall provide computer and manual graphics (drafting). This shall include, but not be limited to facility and equipment illustrations, organization charts, certificates, photograph, guest badges, and guest bus placards.

8.3 Transportation Services

ANALEX shall manage transportation services to meet all operations requirements to include, but not limited to spacecraft servicing equipment on site.

8.4 Shipping and Receiving

ANALEX shall provide services to include shipping, receiving, packing and crating, pick up and delivery of supplies, materials, equipment, and flight hardware. ANALEX shall receive all mail, packages, and truck shipments, check for damage, and notify end user of its arrival. ANALEX shall provide shipment services including overnight and point-to-point package delivery.

8.5 Laboratory Services

ANALEX shall operate and maintain gas-sampling equipment and obtain gas samples from tube bank trailers and K-bottles and coordinate chemical analysis from USAF Chemical Laboratory.

8.6 Non-Destructive Evaluation (NDE) Services

ANALEX shall provide test and inspection services including in situ NDE. ANALEX shall provide a written report detailing inspection results.

ANALEX shall perform non-destructive evaluation of handling equipment after structural modification and proof-load testing. The dye penetrant inspections shall be in accordance with American Society for Testing and Materials Standard Practice for Liquid Penetrant Examination (ASTM E 1417-99). Personnel performing the evaluation shall be trained in accordance with American Society for Nondestructive Testing (ASNT) documents ASNT CP-189-1991 "Standard for Qualification and Certification of Nondestructive Testing Personnel" and SNT-TC-1A "Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing."

8.7 Security Services

ANALEX shall manage all necessary services and equipment needed for security, access permits/badges, and locksmith services.

8.8 Permits and Badges

ANALEX shall provide area access permits/badges for temporarily assigned payload customers and other visiting personnel for access to payload or flight hardware processing areas.

ANALEX shall maintain records of badges issued and account for the non-issued badge stock. ANALEX shall assure that any person being issued an access badge has received the appropriate Safety training required for the corresponding location to be visited.

ANALEX shall provide controlled area permits/badges/entry authorization lists, when required by customer projects within NASA facilities assigned to ANALEX or sub-contractor. ANALEX shall verify that personnel obtaining permits, badges, or inclusion on an entry authorization list meet the requirements for unescorted access within the controlled area.

ANALEX shall provide badge requests for contractor personnel for access to USAF restricted areas.

8.9 Lock and Key Control

ANALEX shall provide lock and key control including periodic inventory of keys in the NASA/Vandenberg Air Force Base (VAFB) master key system, posting classified document containers, changing lock combinations, and maintaining key control records, for facilities where ANALEX has operations and maintenance management responsibility.

8.10 Security Inspections

ANALEX shall provide end-of-workday securing inspections for all NASA-assigned facilities, and log all security inspection efforts.

8.11 Guest Services

ANALEX shall receive/screen requests for visits and process/maintain records of visit requests and authorization letters. ANALEX shall coordinate with entry control personnel in accordance with USAF regulations to assure proper credentials are ready when the visitor arrives. ANALEX shall be prepared to resolve and expedite entry control problems with security officials.

ANALEX shall operate and maintain a system to provide foreign national escort services in support of payload operating schedules. ANALEX shall be responsible for providing continuous escorting and transportation services for foreign national visitors while on USAF/NASA property.

ANALEX shall develop and maintain visitor control lists as required for access to specific areas controlled by USAF and other contractors. ANALEX shall input data into the Visiting Personnel Security Database to include visiting personnel and their facility entry authorization at any given time.

9.0 Mission-Direct Support at Vandenberg Air Force Base (VAFB)

9.1 Payload Support

ANALEX shall provide transportation services for spacecraft and flight hardware to the Payload Processing Facility (PPF)s at arrival.

ANALEX shall provide transportation and setup services for support equipment including the Launch Site Support Trailer. ANALEX shall coordinate transportation and setup services with Communications and Telemetry personnel.

ANALEX shall operate, maintain, and setup the Spacecraft Close-out Shelter (SCS).

9.2 Clean-Room Services and Cleanliness Requirements

ANALEX shall prepare a Facility Contamination Control Plan. ANALEX shall ensure that all Clean Rooms and clean work area facilities and associated support equipment meet payload customer cleanliness requirements. ANALEX shall manage all clean room operations to assure customers follow all established contamination control procedures.

ANALEX shall provide assistance to customers in cleaning equipment prior to moving it into the clean room.

ANALEX shall operate and maintain clean room particle counting equipment.

ANALEX shall implement customer-produced contamination control plans. In the event the customer does not have a written contamination control plan, ANALEX shall coordinate/implement contamination control requirements with the customer.

9.3 Propellant Services

ANALEX shall coordinate requirements for propellant handlers ensembles with the USAF and the USAF protective equipment maintenance and operations contractor. ANALEX shall manage the scheduling of self-contained apparatus protective ensemble (SCAPE) and other propellant handlers protective equipment training for customers.

ANALEX shall coordinate the pre-operations and post-operations servicing of spacecraft fueling equipment.

9.4 Environmental Compliance

ANALEX shall ensure that NASA operations are compliant with all applicable federal, state, county, NASA, USAF environmental rules, regulations, and management plans. ANALEX shall maintain an environmental management program that closely interfaces with NASA and the USAF environmental management efforts. ANALEX shall act as the technical point-of-contact

(POC) and maintain a cooperative working relationship with USAF who has overall environmental compliance responsibility over all.

ANALEX shall represent NASA position in environmental meetings/working groups and provide to NASA evaluations/recommendations about the USAF position.

ANALEX shall provide environmental services to NASA for environmental programs. Services include technical regulatory consultation for interface with regulatory agencies; inspection of regulated facilities and systems; preparation of permits, reports, and other regulatory documents; and development and review of environmental documentation.

9.5 ANALEX shall provide environmental services to NASA operations including:

- Written evaluation and assessment of projects for requirements of the National Environmental Policy Act (NEPA).
- Preparation of NEPA documentation, e.g., Environmental Assessments, Environmental Impact Statements.
- Written evaluation of processes to determine permitting requirements and preparation of permit applications when identified.
- Ensure environmental permits are current and operations are in compliance with permit requirements. Written recommendations for corrective action to correct non-compliances.
- Preparation and delivery of reports to meet regulatory deadlines, e.g., permit compliance reports, Emergency Planning and Community Right-to-Know Act (EPCRA) reports, Toxic Release Inventory (TRI) reports, etc.
- Inspection of regulated facilities and systems for compliance in all media areas. Written recommendations and track corrective action for identified non-compliances.

ANALEX shall be responsible for management of hazardous materials throughout their life cycle – procurement, usage, and disposal. They shall:

- Obtain approval from USAF for use of hazardous materials.
- Maintain records of storage and usage for emergency management purposes and EPCRA and TRI reporting.
- Maintain material safety data sheets (MSDS) for hazardous materials used and/or ensure that MSDS are given to central location.
- Ensure safe storage and use of hazardous materials including development of operational procedures for storage, use, and disposal.
- Control, package, and process hazardous and controlled wastes generated during NASA operations in accordance with Federal, state and local procedures and regulations.
- Provide training to NASA personnel, contractors, and customers concerning the handling and use of hazardous materials and wastes to meet Federal, state, and local training requirements. Maintain the training records in a manner compliant with Federal, state, and local requirements.

10.0 Guard Services at Vandenberg Air Force Base (VAFB)

ANALEX shall provide for continuous (24 hours) guard services for NASA-sponsored payloads while processing in a NASA Payload Processing Facility (PPF) per each access entry at all times. ANALEX shall use authorized access lists and post orders detailing a minimum of tasks to be done to meet security requirements and exercise an emergency call tree.

11.0 Access Control Monitors (ACM) at Vandenberg Air Force Base (VAFB)

ANALEX shall provide trained personnel to perform as Access Control Monitors (ACM) continuously (24 hours) as rquired. Access Control Monitors (ACM) shall be responsible for monitoring personnel

limits in the facility, enforcing safety constraints, logging facility anomalies, contacting appropriate people in response to an anomalous condition, and operating the video and communications systems within the Hazardous Processing Facility. The Access Control Monitors (ACM) shall not perform as a security guard. In the event of an anomalous occurrence, the established call tree shall be exercised.

12.0 Satellite Uplink Services for NASA Public Affairs Support

For Vandenberg Air Force Base (VAFB) missions, ANALEX shall provide mobile satellite uplink services for a NASA sponsored mission to support mission-direct activities including an end-to-end communications test prior to launch day and/or a launch attempt.

13.0 Vehicle Engineering And Analysis

ANALEX shall perform engineering and analyses for the NASA Program. ANALEX shall review and evaluate Launch Service Provider (Launch Service Provider (LSP)) tasks and products delivered as part of each expendable launch vehicle launch service so that the NASA Vehicle Engineering Division can provide approval of mission unique items and a knowledgeable “go/no-go” for NASA missions.

As required, ANALEX shall prepare and deliver technical briefings to spacecraft and launch vehicle external review teams.

ANALEX shall have the ability to investigate and evaluate the design, modification, development, and implementation of all launch vehicle systems, ground support systems and equipment at all Expendable Launch Vehicle (ELV) and payload processing facilities and launch complexes used to provide Expendable Launch Vehicle (ELV) launch services to NASA. ANALEX shall review, evaluate and provide an assessment of launch vehicle systems where NASA identifies a requirement for technical insight into the development, design, manufacturing, testing, integration, and launch of the affected systems and launch vehicle.

ANALEX shall participate in Launch Service Provider (LSP) run reviews and payload customer reviews, which are chaired by NASA personnel, in order to provide technical evaluations and recommendations of the designs, analyses, manufacturing methods, tests, and operations presented at those technical meetings. The meetings include technical interchange meetings (TIM), mission integration working groups (Mission Integration Working Group (MIWG)), preliminary design reviews (PDR), critical design reviews (CDR), design certification reviews (DCR), Quarterly Program Reviews (QPR), Payload Planning Meetings, Payload Ground Operations Working Group (GOWG), Safety Review Meetings, Flight Readiness and Launch Readiness Reviews.

ANALEX shall review, evaluate, and provide technical assessment of all required Launch Service Provider (LSP) documents delivered as part of the integration of each Expendable Launch Vehicle (ELV) mission so NASA can approve items specified in the launch service contracts (e.g., Contract Data Requirements List (CDRL), Mission Integration Working Group (MIWG) minutes and action items). ANALEX shall be well versed in analyses methodologies used by all NASA Launch Service Provider (LSP)s. For assessments of Launch Service Provider (LSP) Contract Data Requirements List (CDRL), ANALEX shall provide a written report to the NASA Mission Integration Team to include a summary of the Contract Data Requirements List (CDRL) reviewed, rationale for agreement or disagreement, ground rules used for any contractor analysis performed, results and sound explanation which corroborate contractor analytic results, final conclusions and recommendations, and appropriate identification of risk and risk rating. At a minimum, ANALEX shall identify all significant issues that could potentially impact mission success, schedule milestones, or cost for NASA resolution with the Launch Service Provider (LSP).

Throughout the life cycle of each NASA mission, from identification of mission requirements until completion of post-launch data review, ANALEX shall gather data from Launch Service Provider (LSP)s

and spacecraft customers as well as perform their own independent research. ANALEX shall evaluate and assess mission specific launch vehicle systems, mechanical and electrical interfaces, mission-specific software, predicted spacecraft environments, and Launch Service Provider (LSP) actions for NASA missions. . Contractor technical assessments shall be provided to NASA for NASA resolution with the Launch Service Provider (LSP).

Throughout the build cycle for each NASA launch vehicle, from design requirements development until completion of post-launch data review, ANALEX shall participate in NASA and Launch Service Provider (LSP) technical activities and take all other steps necessary to maintain a knowledge base adequate to ensure prompt, accurate and complete evaluation of all flight and ground system technical issues or anomalies effecting NASA missions. The assessments shall include documentation of discrepancies, dispositions and corrective action plans. This requires knowledge for all Expendable Launch Vehicle (ELV) systems utilized by the NASA Launch Services Program Office, including knowledge of specific vehicles assigned to NASA and to non-NASA missions. .

ANALEX shall gather data, review telemetry, research requirements, review as-built documentation and as-run procedures, and perform any other investigative steps necessary to prepare and present evaluations to NASA-chaired Failure Review Board (FRB) meetings in the event of a failed mission. Evaluations of anomalies shall be presented to the Kennedy Space Center (KSC) Engineering Review Board. ANALEX shall evaluate the failed or anomalous systems in order to aid the determination of root cause so that NASA can direct or approve Launch Service Provider (LSP) corrective action plans and/or return-to-flight activities.

14.0 Mission Analysis

ANALEX shall provide rapid, accurate, and complete assessments of analytical items throughout the life cycle for each NASA mission and build cycle for each NASA vehicle. ANALEX shall perform reviews of Launch Service Provider (LSP) provided documents in order to ensure prompt technical assessments of all relevant issues that arise during the integration process. Evaluation of these issues may require ANALEX to perform an independent analysis in order to verify or better understand the Launch Service Provider (LSP) data. Documentation of evaluations and recommendations to NASA shall be such that NASA approval of analyses and/or direction to the Launch Service Provider (LSP) for corrective actions can be accomplished. The analytical areas that shall be covered include the following:

- Loads and Structural Dynamics
- Dynamic Environments
- Stress
- Flight Design
- Flight Software
- Controls and Stability
- Thermal/Thermodynamics
- Electromagnetic Compatibility
- CFD/Aerodynamics

ANALEX shall evaluate Launch Service Provider (LSP) analyses for compliance with applicable mission and vehicle requirements for each of the disciplines listed above so that the NASA Vehicle Engineering Division can provide prompt approval of mission unique items and a knowledgeable “go/no go” for NASA missions. ANALEX shall evaluate and provide technical assessments to NASA of the relevant Launch Service Provider (LSP) Contract Data Requirements List (CDRL), vehicle system design, testing (such as that required for flight software or environments), robustness in the areas of performance and reliability, and post flight data.

For all of the disciplines listed above, specific technical expertise required by ANALEX shall include the ability to:

- Develop and create complex vehicle models
- Simulate these models using relevant code
- Modify or update analytical code as required
- Understand the Launch Service Provider (LSP) tools and models such that input and output files can be reviewed efficiently and accurately.
- Review incoming reports and perform analytical checks as required

15.0 Vehicle Systems Engineering

ANALEX shall provide rapid, accurate, complete assessment of vehicle systems issues and provide notification to the NASA Vehicle Systems Lead and the NASA Chief Engineer in accordance with the Engineering Review Process. ANALEX is responsible for reviewing and evaluating Launch Service Provider (LSP) tasks and products so the NASA Vehicle Engineering Division can provide prompt approval of mission unique items and a knowledgeable "go/no-go" for NASA missions. ANALEX or sub-contractor's vehicle systems engineers shall evaluate and provide technical assessments of the Launch Service Provider (LSP) launch vehicle systems design, analyses, manufacturing, verification, validation, assembly, integration, testing, checkout, and launch preparations for compliance with applicable requirements and robustness in the areas of performance, safety, reliability, and quality.

ANALEX shall provide expertise in the following areas:

- Electrical/Avionics Engineering: electrical wiring avionics boxes, guidance and control systems, vehicle instrumentation, vehicle telemetry, vehicle Radio Frequency (RF) systems vehicle power systems, data acquisition/handling systems and Ground Launch Control Software, and electrical ground support equipment.

- Mechanical/Structural Engineering: structures, composite materials, payload adapters, mechanical separation systems, pneumatics systems, hydraulics systems, liquid and solid propulsion systems, ordnance systems, and contamination control methods.

16.0 Electrical/Avionics Engineering

ANALEX shall assess flight and ground Expendable Launch Vehicle (ELV) electrical and avionics systems for NASA's determination of their readiness for launch.

ANALEX shall assess mission unique requirements imposed on the design, modification, development, implementation, and flight performance of all electrical and avionics systems.

ANALEX shall participate in, and assess launch vehicle processing, payload integration and testing activities at both the launch site and at payload customer facilities (e.g., fit-checks) to verify overall Launch Service Provider (LSP) compliance with test procedures and acceptability of test results

17.0 Mechanical/Propulsion Engineering

ANALEX shall assess flight and ground Expendable Launch Vehicle (ELV) mechanical and structural systems for NASA's determination of their readiness for launch. ANALEX shall determine failure trends of components and investigate latent defects.

ANALEX shall review and assess mission unique requirements imposed on the design, modification, development, implementation, and flight performance of all mechanical and structural systems.

ANALEX shall participate in and assess launch vehicle processing, payload integration and testing activities at both the launch site and the payload customer facilities (e.g., fit-checks, environmental testing, payload shock testing) to verify overall Launch Service Provider (LSP) compliance with test procedures and acceptability of test results. In addition, ANALEX shall evaluate and make recommendations on payload mechanical compatibility drawings for human access verification.

ANALEX shall participate in and assess Launch Service Provider (LSP) plans to comply with mission cleanliness requirements in processing facilities, during transportation and payload/Expendable Launch Vehicle (ELV) integration, and under fairing environments. ANALEX shall provide expertise in materials utilization/compatibility with mission unique requirements according to contamination control plans.

18.0 Electronic Drafting

ANALEX shall provide electronic drafting capability to create, design and maintain 2-dimensional (2D) and 3-dimensional (3D) drawings.

ANALEX shall develop and maintain diagrams, schematics, modeling for accessibility and/or feasibility assessments for mission integration requirements and launch vehicle systems. ANALEX shall provide diagrams, schematics and modeling studies as part of the Engineering Review Process and the Mission Integration activities. Results to be supplied on hard copy and electronically to NASA.

EXHIBIT 2

Supporting Technical Data
on
Bristol Aerospace Limited
The SciSat Payload
SciSat Sensor Description

History of Bristol Aerospace Limited, a Magellan Aerospace Company

Our history began in 1914, when two brothers named Jim and Grant MacDonald came to Winnipeg and started a sheet metal business. At the time, aviation was in its infancy. But by the late 1920s, air travel had become an important means of transportation. Western Canada's economy was booming, and Winnipeg was its transportation centre; often called the "Gateway to the West". The lack of adequate roads, railroads, and airfields necessitated the use of float planes.

It was the need for sea planes, sea plane floats in particular, that prompted the MacDonald Brothers to form MacDonald Brothers Aircraft Company in 1930. Its first product was sea plane floats, which it manufactured under a licence from EDO Corporation of New York, and which it continued to manufacture until the early 1980s. The Company developed into a full-fledged aircraft manufacturer by 1940, when during the second world war it employed 4,500 people.

Shortly after the war, Bristol became the repair and overhaul centre for the fledgling Canadian Air Force. The Company's location was considered ideal because Winnipeg is in the centre of the country. The city subsequently became the location of Canada's Air Command. Throughout the 1940s and 1950s the Company performed depot level inspection and repair for many of Canada's early fighter planes, such as the Mustang.

The 1950s saw the broad acceptance of the gas turbine, or jet engine. Bristol was involved on the ground floor of this new technology when it began building jet pipes for the CF100 Canuck, and subsequently won the maintenance contract for the airframe. During the rest of the 50s and 60s, Bristol built on experience in exotic materials and precision sheet metal fabrication to become a major supplier of hot section components for the gas turbine industry.

Bristol really began to spread its wings during the early part of the 1960s, when it moved into four new areas of business: repair and overhaul of jet engine afterburners, helicopters, solid rocket propellant, and nuclear reactor components.

top

The Company won its first helicopter contract in 1961. The aircraft was the Hiller UH-12, and was assembled by Bristol for the Canadian Armed Forces. Also in 1961, the Company began developing solid propellant driven research rockets, which later became known as Black Brants. The Rockwood Propellant Plant was established one year later, on a 3000 acre site north of Winnipeg.

Bristol's next diversification was a result of the ingenuity of its aircraft engineers. In the early 1960s the Canadian and US Air Forces were having trouble with a new development in propulsion, the afterburner. At that time, Bristol had recently won the repair and overhaul contract for the CF-101 Voodoo, and had observed that problems with the afterburners on its J57 engines were severely reducing its reliability. A technical study was done, and a proposal for a repair and modification program was submitted. The intent was to accomplish two things: first, to save the cost of replacement; second, to improve reliability. The proposal was accepted, and

the program was a complete success; as the service life of the afterburner more than doubled. Bristol has since become a centre of excellence for afterburner repair for the US and Canadian Armed Forces.

The 50s and 60s were also an interesting time for Bristol in terms of ownership. The Company had three name changes during this period, the first of which occurred in 1954 when MacDonald Brothers Aircraft was purchased by the Bristol Aeroplane Company. It was renamed Bristol Aerojet in 1962, and finally became Bristol Aerospace Limited in 1967 when it was acquired by Rolls-Royce Industries.

During the 1970s Bristol built upon its diversification of the 1960s. The new business areas grew in size and became very successful. Jet engine components, afterburners, nuclear and aircraft repair and overhaul continued very strongly. The latter in particular, was important because the CF-101 Voodoo contract continued through to 1984, and Bristol was also successful in its bid for the depot level inspection and repair contract for Canada's medium to light helicopters in 1971.

The 70s were also important because Bristol began to acquire many new manufacturing processes. The most significant of these was composite manufacturing, which enabled Bristol to win the contract for several large aircraft structures, such as the S-Duct for the Lockheed L-1011 and several wing parts for the de Havilland Dash 8. The former was a complex, double bonded structure, which required many innovative metal forming techniques.

top

The late 70s brought a significant transition to Bristol; namely, the emergence of proprietary products as a major component of the Company's business. The most notable of these were the CRV7 defence rockets, helicopter Wire Strike Protection System, and the Black Brant research rocket. These three products have grown to be extremely successful export products for Bristol to this day.

CRV7 is in continuous operation with forces of NATO, ASEAN, Australasia and the Middle East. The Company's newest variant of the product - the C17 motor - is optimized for use on helicopter platforms. The future success of this product may be indicated by the fact that the first major competition for such a product was won by the CRV7 (UK Attack Helicopter Program). Development of new products for this system continues.

The Wire Strike Protection System is now available for most makes and models of helicopters, with OEMs now planning for its inclusion from the drawing board stages of new helicopters versus its original retrofit design.

In January 1987, Bristol was appointed the principle industrial support centre for Canada's fleet of CF-5 aircraft. As such, Bristol became the world leader in the modernization of this aircraft. The Canadian Government made the decision to retire these aircraft in 1995 in response to budget cutbacks, offering the assets for sale through Bristol.

The 800th Black Brant was launched in the summer of 1999. Bristol's expertise in the sounding

rocket arena has led the Company into further Space Science programs, covering the gambit of rocket and space shuttle payloads to small satellites.

In 1999 Bristol was awarded the contract to build SCISAT-1 for the Canadian Space Agency. SCISAT-1 is the first Canadian science satellite built since 1971 and scheduled to be launched in March 2002.

In 1997 Bristol was acquired by the Magellan Aerospace Corporation. Magellan (MAL) is listed on the Toronto Stock Exchange and has operating divisions throughout the United States and Canada.

Today, as a Magellan Aerospace Company, Bristol continues to develop new technologies and incorporate new processes for future growth.

Defence and Space Products Summary

Black Brant Sounding Rockets

Whether studying the upper atmosphere or conducting micro-gravity research, the Black Brant is the most reliable, cost effective, and available sounding rocket to carry experiments to the fringes of space. Bristol's solid propellant single or multi-stage Black Brant rockets provide the lowest cost access to space. Providing up to 12 minutes of useful time for micro-gravity experiments, aurorial studies, deep space observations or other extraterrestrial research, the Black Brant can carry payloads up to altitudes in excess of 1,500 kilometres and has a demonstrated reliability of over 98% in more than 800 launches.

CRV7 Rocket Weapon System

The CRV7 is the leading 2.75" unguided rocket weapon system available today. It offers greater stand-off distances, higher kinetic energy and superior accuracy to both fixed wing and helicopter users.

The system offering includes rocket motors, launchers and warheads in various models, depending upon mission objectives. With a 99% reliability, almost 700,000 of these cost effective rockets have been produced.

The CRV7 is in service in Canada and with various forces of NATO, ASEAN and Australasia. Optimized for use on helicopters, the latest development of the C17 variant, the CRV7 has been chosen for the UK Apache Attack Helicopter program.

Pyrophoric Infrared Flares

The purpose of pyrophoric flares is to decoy Infrared (IR) seeking missiles away from aircraft. Most flares available today are pyrotechnic, burning with a concentrated IR radiation plume. Bristol's liquid pyrophoric flare is designed to match an aircraft's IR spectrum to defeat advanced missile threats. The flare expels a liquid that burns on contact with the air creating an aircraft-size IR signature image that confuse the inbound threat seeker.

Small Satellites

Bristol has been selected by the Canadian Space Agency to build Canada's first science satellite the SCISAT-1.

Space Payloads

Payload and vehicle support systems are an integral part of the Black Brant program. Designed to meet the needs of experimenters from all over the world, they range from forward ejecting nose fairings to payload recovery by parachute.

GyroWheel™

The GyroWheel™ is a novel spacecraft attitude control device that has the unique ability to provide 3-axis control torques while at the same time functioning as a gyroscope measuring the spacecraft angular rates about 2-axis. The GyroWheel™ can provide significant benefits over conventional ADCS technology and is applicable to a broad range of spacecraft missions. This technology will allow for significant reduction in mass, size, power, and cost for fine pointing spacecraft ADCS systems. The GyroWheel™ will be flown on the Canadian Space Agency's SCISAT-1 spacecraft in 2002.

Black Brant Sounding Rockets

Black Brant is a solid propellant rocket system in single and multistage configurations that can carry payloads of 70-850kg to altitudes from 150km to more than 1500km.

It provides up to 20 minutes of useful time for micro-gravity experiments, auroral studies, deep space observations, and other extraterrestrial research.

Black Brants are launched from conventional boom rails or 3 to 4 fin towers.

Bristol's Space Systems Group can provide a comprehensive range of vehicle/payload design and fabrication through full launch support worldwide.

Since 1962, more than 800 Black Brants have been launched, with a vehicle success rate of 98%.

Vehicles are in continuous production at Bristol for ready availability to experimenters. High rates of production help keep the Black Brant more cost-effective than any other sounding rocket of comparable performance.

Whether studying the upper atmosphere or conducting micro-gravity research, the Black Brant is the most reliable, cost-effective, and available sounding rocket to carry experiments to the fringes of space.

Support Services/Facilities

Bristol's Space Systems Group, staffed by many of Canada's foremost experts in high altitude research rocketry, offers turnkey services and support to experimenters:

- mission feasibility and definition
- payload/hardware design and fabrication
- experiment integration
- environmental testing
- mission analysis
- launch services and range crew support
- project management

Notable Events

Launch of the first Black Brant 12 from Wallops Island, Virginia, in 1988.

Static firing of Black Brant motor at Rockwood, Bristol's solid propellant plant. Since 1963, when the plant opened, it has produced over 700,000 rocket motors for a variety of applications.

Launch of a BB 9 from 4-fin tower at White Sands, New Mexico. The payload carried micro-gravity experiments in support of the Canadian Space Agency's materials research program.

Environmental testing ensures that "what goes up does not break down".

Space Payloads

Payload and vehicle support systems are an integral part of the Black Brant program. Designed to meet the needs of experimenters from all over the world, they range from forward ejecting nose fairings to payload recovery by parachute.

OEDIPUS

OEDIPUS-A, launched on January 30, 1989, was a Canadian Space Agency space physics mission undertaken in co-operation with NASA. OEDIPUS-A was launched on a 3-stage Black Brant 10 vehicle from Andoya Rocket Range in Norway. The principle scientific objectives of the mission were to make electric field, electric wave, magnetic field and particle measurements in the earth's ionosphere up to an altitude of 600 km. Bristol was the payload prime contractor with responsibility for mission planning and payload design, manufacture, integration, test and launch support.

OEDIPUS-C, launched on November 6, 1995, was a follow-on mission to the OEDIPUS-A. OEDIPUS-C was flown on a 4-stage Black Brant 12 vehicle launched from Poker Flat Research Range in Alaska. The science objectives were to study the natural and artificial waves in the ionospheric plasma as well as the dynamics of a spinning tethered space system. Bristol was the payload prime contractor with responsibility for mission planning and payload design, manufacture, integration, test and launch support. The mission was 100% successful, with the payload reaching an apogee of 824 km.

Geodesic

The Geoelectrodynamics and Electro-Optical Detection of Electron and Suprathermal Ion Currents (GEODESIC) experiment studied the Northern Lights during a 17 minute suborbital flight on March 4, 2000 from Alaska's Poker Flat launch facility.

The experiments' Black Brant 12 launch vehicle reached an altitude of 1,000 kilometres, allowing the GEODESIC instrument to study small pockets of energy in the upper atmosphere associated with the Northern Lights. These pockets of energy are believed to attain temperatures of more than 1 million degrees Celsius.

Bristol manufactured the Black Brant rocket and built the GEODESIC payload.

Visuo-motor Coordination Facility

The Visuo-motor Coordination Facility (VCF) is a test platform used to measure the hand-eye coordination and reaction time of subjects in a reduced-gravity environment.

The experiment was launched from Florida's Kennedy Space Center on the Space Shuttle Columbia in April 1998. The Bristol-manufactured VCF was part of a multi-national group of experiments for NASA's Neurolab Mission.

The VCF experiment was performed by the shuttle crew before, during, and shortly after the Neurolab flight. The recorded data, was analyzed for evidence of deficits to visuo-motor coordination during the early exposure to weightlessness, if any compensation was observable later during the flight, and if any after effects were evident upon return to earth.

A number of paradigms were performed to capture different aspects of the astronauts' performance (i.e., pointing, grasping, tracking movements, and responses to sudden and gradual target changes). The VCF used a laptop computer and reflective optics to present a virtual target image to the astronaut. Stereoscopic cameras measured the astronaut's hand position and movement in response to a set of prescribed target paradigms.

Bristol Aerospace was responsible for the software design, hardware manufacture, test, and interface with NASA on the safety documentation process. The project was sponsored and managed by the Canadian Space Agency, Life Sciences Division, NASA, and the German Space Agency, DARA [now merged into DLR.]

CSAR

CSAR-1 rocket payload was launched on March 19, 1992. CSAR -1 was the first flight in the Canadian Space Agency's "Canadian Microgravity Rocket Program", that focused on the investigation of liquid and gaseous material behaviour in a reduced gravity environment. CSAR-1 was launched on a 2-stage Black Brant 9 vehicle from White Sands Missile Range, NM.

The CSAR-1 mission was comprised of 5 scientific modules, housing 52 experiments, dealing with fluoride glass crystallization, silicon carbide whisker growth, aluminum alloy solidification, and polymer degradation in space. Bristol was the payload prime contractor with responsibility for mission planning and payload design, manufacture, integration, test and launch support. Launch services were procured through NASA. The payload was carried to an altitude of 240 km and achieved a microgravity period of 6 minutes.

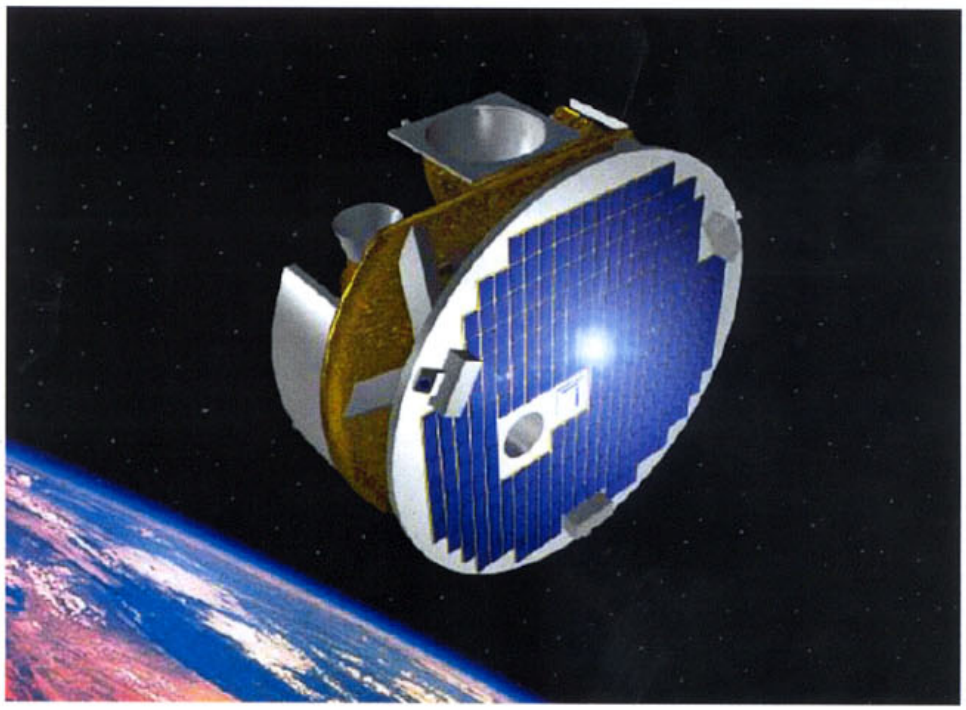
CSAR-2, launched on 8 December 1994, was the second flight in the Canadian Microgravity Rocket Program, for science experiments in a reduced gravity environment. The nature of the CSAR-2 mission was similar to that of CSAR-1. In an effort towards standardization and cost reduction, CSAR-2 re-used many of the standard facilities developed for CSAR-1. Five experiment modules were developed for this payload. Bristol was the payload prime contractor responsible for mission planning and payload design, manufacture, integration, test and launch support.

MAGELLAN
AEROSPACE CORPORATION

SCISAT-1 SMALL SATELLITE MISSION

SCISAT-1 is a small scientific satellite developed for the Canadian Space Agency (CSA). The mission, Atmospheric Chemistry Experiment (ACE), will determine the chemical makeup of the atmosphere by collecting data on the absorption of the sun's rays by the atmosphere during the sunrise and sunset of each orbit.

Bristol Aerospace is the prime contractor for the design and manufacture of the SCISAT-1 spacecraft bus. Bristol designed the spacecraft bus for a two year mission life, with component derating to allow extension to five years. The SCISAT-1 spacecraft bus offers a low-cost, high reliability solution to the mission.



SCISAT-1 will be launched in May 2003.

Orbit:	*650 km at 74° inclination*
Launch Vehicle:	*Pegasus XL vehicle*
Operating Life:	*Two years*
Total Spacecraft Mass:	*152kg (47kgs for the instruments)*
Scientific Payload:	*ACE-FTS (Bomem Ltd.) and MAESTRO (EMS Technologies Canada)*
Attitude Control:	*Bias momentum stabilized sun-pointing to within 1°*
Power:	*Fixed Solar Array: ~80 WOA*
Data Storage:	*1.5 Gbyte, 99% for science usage*
Telemetry:	*S-band, NASA STDN*
Downlink:	*Data rates to 4 Mbps*
Uplink:	*Data rate of 4 kbps*

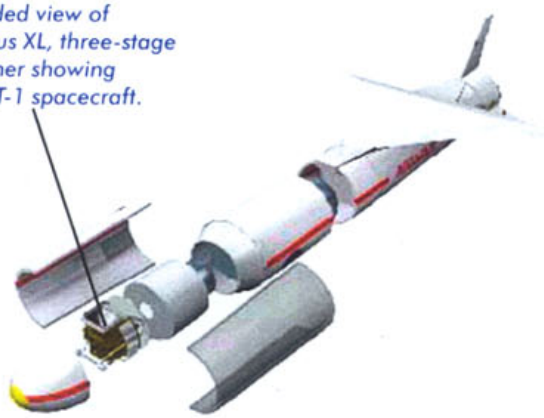
SCISAT-1 is a collaborative mission between the CSA and the US National Aeronautics and Space Administration (NASA). SCISAT-1 will be launched by a Pegasus XL vehicle in May 2003.

The scientific payload consists of two instruments: FTS (Fourier Transform Spectrometer) designed by Bomem Ltd., and the MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) designed by EMS Technologies Canada. Both instruments will gather information on the chemical constituents and dynamic processes occurring in the earth's atmosphere between 4-100 km.

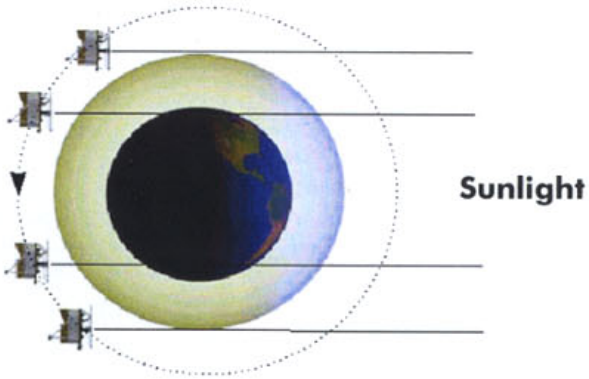
The measurements obtained by the FTS and MAESTRO instruments will be combined with data gathered by ground-based, balloon-based, and other space-based projects in order to obtain information and predict future trends relating to the ozone layer and its depletion.

The SCISAT-1 orbit will provide the scientific payload extensive coverage of the atmosphere with an emphasis on the mid-latitude areas, such as Canada, the United States, as well as the polar regions. SCISAT-1 will orbit the Earth 15 times a day, providing 30 daily opportunities (sunrises and sunsets) to take its measurements.

Exploded view of Pegasus XL, three-stage launcher showing SCISAT-1 spacecraft.



Periods in the orbit when solar occultation data is collected.



CORPORATE INFORMATION

Bristol Aerospace, a Magellan Aerospace company, has more than 40 years experience in the development, manufacture and integration of space systems for the Canadian Space Agency, NASA, and other international customers.

Bristol Aerospace is at the forefront in bringing scientific theory into reality. The company manufactures launch vehicles, small satellites, space payloads, and space hardware that advances our understanding of the Earth and our universe. Our engineering team offers customers turnkey solutions and leading technology for various space missions.

Suborbital Launch Vehicles:
Bristol is the manufacturer of the Black Brant suborbital rocket. More than 1000 Black Brant rockets have been launched from 20 sites around the world with an overall reliability record of 98.5%. Reaching altitudes of 1500 kms, these missions perform science in the areas of astronomy, microgravity, communications, and astrophysics.

Space Payloads:
Bristol has designed and manufactured more than 130 payloads for rocket and space shuttle missions.

For Information, contact David T. O'Connor
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Printed in Canada
January 2003

GYROWHEEL™

The Bristol GyroWheel™ is an innovative spacecraft attitude control system device that provides both an angular momentum bias and control torques about three axes while also measuring the spacecraft angular rates about the two axes perpendicular to the spin direction.

(Patent Pending)

Flex Gimbal

The GyroWheel™ consists of a spinning rotor attached to a drive shaft through a novel gimbal system which uses flex pivots on two axes to enable tilting the rotor up to 7° from the shaft. Torque coils that are fixed to the housing interact with permanent magnets mounted in the rotor to allow steering the angular momentum vector. Optical sensors are used to sense the transitions on a triangular pattern machined on the outside spherical surface of the rotor to provide an accurate tilt angle measurement.

An embedded digital signal processor (DSP) is housed internally along with the required drive electronics for the brushless DC spin motor, the torque coils, and the tilt sensors.

Digital control loops perform the rotor speed and tilt control based on momentum commands from the spacecraft attitude control system. Precise measurements of the rotor speed and tilt angles, and the torque coil currents are used in a proprietary algorithm to establish the spacecraft rates about two axes.

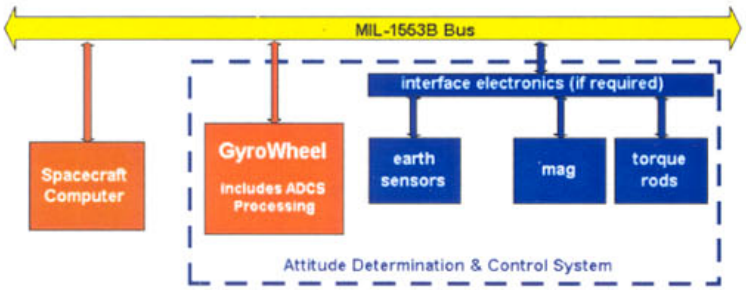
APPLICATION

The GyroWheel™ has broad applicability to many spacecraft types including earth, sun and inertial pointing missions. A large range of spacecraft sizes can be accommodated due to the broad bias momentum range. This is achieved by varying the speed and also the rotor mass (several rotor options are available).

For earth or sun pointing misisons, the 7° rotor tilt range is sufficient to absorb disturbance torques. For inertial pointing applications, two GyroWheels can be used spinning in opposite directions. The GyroWheel™ rate sensing capability offers many benefits including providing the ability to determine yaw without the need for a direct yaw measurement (based on gyrocompassing principles). Also, the embedded DSP has significant excess processing capability that can be used to perform all the required ADCS processing functions. This can be facilitated using the standard bus interface option.

GyroWheel™ Tilt Sensor Testing

POSSIBLE GYROWHEEL™ BASED 3-AXIS ADCS IMPLEMENTATION

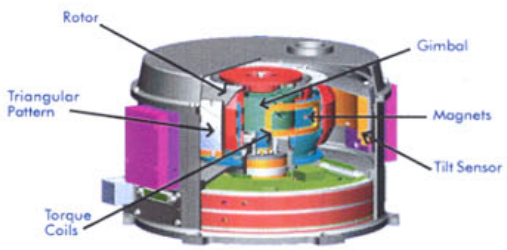


PERFORMANCE SPECIFICATIONS AND INTERFACES

Size	23.5 cm dia. x 13.5 cm high
Momentum Range	1 - 16 N-m-s
Speed Range	1200 - 6000 rpm
Maximum Rotor Tilt Angle	± 7 deg
Mass	
4 Nms Config	5.5 kg
16 Nms Config	6.75 kg
Power	
Steady State @ 1500 rpm	15.5 W
Maximum @ 6000 rpm & full torque (3-axes)	101 W
Min. Spin Axis Reaction Torque	
1200 rpm	76 mN-m
5900 rpm	63 mNm
6000 rpm	56 mNm
Min. Tilt Axis Reaction Torque	
0 deg tilt	122 mN-m
4 deg tilt	113 mNm
7 deg tilt	80 mNm
Static Balance	< 1 gm-cm
Equivalent Dynamic Balance (disturbance torque)	
0 deg tilt	0.01 gm-cm^2
4 deg tilt	4.6 gm-cm^2
7 deg tilt	8 gm-cm^2
Rate Sensing	
Bias Repeatability	<1 deg/hr
Bias Stability (60 min)	<1 deg/hr
Noise	<0.1 deg/hr$^{1/2}$ (ARW)
On-board Processing Capability	16 MIPS total 12 MIPS available for ADCS
Radiation Tolerance	100 kRad (Si) total dose immune to destructive SEE's
Operating Life	> 10 yrs
Input Voltage	28 ±6 V DC
Electrical Interface	
Serial	RS-422
Bus (optional)	MIL-STD 1553B
Command and Data Interface	
Actuator command formats	Torque, momentum, speed & tilt
Telemetry formats	User definable

KEY FEATURES AND BENEFITS

- applicable to a broad range of spacecraft
- the GyroWheel™ is about the same size, mass and power as a single conventional wheel, but provides much more capability:
  - full 3-axis control torque actuation
  - 2-axis S/C rate measurements
  - ADCS processing capability
- the bearing cartridge uses state-of-the-art materials and a hybrid-integral design to provide exceptional load capacity, fatigue life and high reliability
- the flex gimbal can withstand launch loads without caging the rotor and has infinite life
- for momentum bias applications, the spacecraft rate measurements can be used to determine yaw without the need for a yaw sensor
- the primary benefit of GyroWheel™ is that it allows for substantial savings in mass, power, and above all, cost of the attitude control system



Cutaway Model

Assembled GyroWheel™

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Printed in Canada
January 2003

Canada's Next Scientific Satellite Mission:
The Atmospheric Chemistry Experiment (ACE) Onboard SCISAT-1

Background

SCISAT-1, the first new Canadian scientific satellite since 1971, is scheduled for launch by the National Aeronautics and Space Administration (NASA) in mid-year 2003. On February 4, 1999 the Government of Canada announced the selection of the Atmospheric Chemistry Experiment (ACE) as the scientific mission of SCISAT-1.

The Atmospheric Chemistry Experiment (ACE)

The major scientific goal of the Atmospheric Chemistry Experiment (ACE) mission is to measure and understand the chemical processes that control the distribution of ozone in the Earth's atmosphere, especially at high altitudes. The data that will be recorded as SCISAT-1 orbits the Earth will help Canadian scientists and policy makers to assess existing environmental policy, and to develop protective measures for improving the health of our atmosphere and preventing further ozone depletion. The ACE mission is designed to last at least two years.

The Mission Scientist is Dr. Peter Bernath from the Department of Chemistry at the University of Waterloo. He heads a Science Team that includes Canadian scientists as well as scientists from the United States, Belgium, Japan, France and Sweden. Participating organizations include Trent University, University of Toronto, University of Saskatchewan, University of Waterloo, University of Western Ontario, York University, Université Laval, University of Denver, Nagoya University (Japan), Institut d'Aéronomie Spatiale de Belgique, Free University of Brussels (Belgium), Swedish Environment Research Institute, Centre National d'Études Spatiales (CNES/France), the Meteorological Service of Canada (Environment Canada), ITT Industries (US), and NASA Langley. NASA's Earth Sciences Enterprise and Institut d'Aéronomie Spatiale de Belgique are also Contributing Partners.

The SCISAT-1 satellite

SCISAT-1 is the first Canadian scientific satellite since the ISIS II satellite was launched in 1971. Here are some quick facts about the new satellite:

Total mass:	150 kg
Total power usage:	70 W
Powered by:	single solar panel
Total memory:	1.5 Gigabyte
Spacecraft contractor:	Bristol Aerospace – Winnipeg, Manitoba
Scientific Payload:	ACE-FTS (Bomem Ltd.) MAESTRO (MSC, U of T, EMS)

Scheduled launch date:	mid-year 2003
Launch vehicle:	Pegasus XL rocket
Orbit:	650 km above the Earth
Number of times SCISAT-1 will circle the Earth in 1 day:	15
Number of sunrises and sunsets SCISAT-1 will see in 1 day:	30

ACE-FTS Onboard SCISAT-1

The ACE mission consists of a Fourier Transform Spectrometer (ACE-FTS) instrument and the Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO) instrument. Both instruments are designed to gather information on the chemical processes occurring in the ozone layer, approximately 8 km to 50 km above the Earth's surface.

Mission Science Objectives

The principal goal of the Atmospheric Chemistry Experiment (ACE) mission is to investigate the chemical processes that are involved in the distribution of ozone in the atmosphere. The ACE mission will work in conjunction with other instruments and missions planned by NASA, the European Space Agency, and other international partners over the next decade to gain a better understanding of the chemistry and dynamics of the atmosphere that affect the Earth's protective ozone layer. The analysis of the large amount of data that will be collected will lead to a more informed assessment of international environmental policies such as the Montreal Protocol for the elimination of chlorofluorocarbons (CFCs).

The overall objective of the ACE mission is to improve our understanding of the depletion of the ozone layer, paying close attention to what is happening over Canada and the Arctic. The measurements obtained by the ACE-FTS and MAESTRO instruments will be combined with data gathered by ground-based, balloon-based and other space-based projects in order to obtain the best possible information to predict future trends relating to the ozone layer and its depletion.

The Government of Canada is working with the international scientific community to determine the extent and causes of atmospheric changes that threaten human health and safety. Sound scientific data is essential to finding effective solutions to problems such as depletion of the ozone layer and climate change. Environment Canada's studies of the ozone layer, which began over 50 years ago, support a worldwide research and atmospheric monitoring program. And through the leadership of the Canadian Space Agency, Canada is also involved in research studying the ozone layer from space.

Canadian scientists are world leaders in studies of the atmosphere related to ozone depletion. The Canadian Space Agency is flying another Canadian instrument called OSIRIS on Odin, a

Swedish satellite launched on February 20, 2001. This instrument also measures the global amount of ozone and its findings will be compared with the ACE mission results.

The Canadian Space Agency also launched a prototype OSIRIS instrument in April 1998 on a rocket from Churchill, Manitoba, and another similar instrument on the MANTRA balloon from Vanscoy, Saskatoon, in August 1998 and August 2000, to help our understanding of this complex atmospheric region. A third MANTRA balloon launch is scheduled in August 2002.

Canada's important role in the study of the ozone

The Canadian Space Agency, both in the past and now with the ACE-FTS and the MAESTRO instruments, continues to provide opportunities for Canadian involvement in space-based ozone research. Canadian scientists first started measuring ozone levels over Canada in the 1930s. In the 1980s this continued research led to the discovery that the ozone layer over Canada was being depleted. Scientists have found indications that over the past 20 years the total average ozone level over Canada has declined by six per cent. Of additional concern is the severe 20-40 per cent ozone depletion observed in the Arctic in early spring.

Maintaining and enhancing Canada's expertise in ozone research is crucial. Canada's northern geography makes it one of the most vulnerable countries in the world when it comes to the effects of ozone depletion in the Arctic region. Since the ozone layer is responsible for protecting us from harmful UV-B rays from the sun, any reduction in the layer is cause for alarm. Increased exposure to UV-B rays results in higher numbers of cases of skin cancer, eye damage and weakened immune systems.

Advances in our understanding of the mechanisms responsible for ozone losses will tell us whether an ozone "hole," such as the one found in Antarctica, is likely to occur above Canada in the future. More importantly, continued research, such as that which will be carried out on the ACE mission, will also help us identify how the ozone layer can be restored and preserved, thus protecting the health and well-being of all Canadians.

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SCISAT-1: The Fourier Transform Spectrometer (ACE-FTS)

Background

The Fourier Transform Spectrometer (ACE-FTS) is the primary instrument selected for the Atmospheric Chemistry Experiment (ACE) mission onboard the SCISAT-1 satellite. A second instrument, Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO), will also fly onboard SCISAT-1, scheduled for launch by NASA mid-year 2003.

The ACE-FTS will be built in co-operation with the Canadian Space Agency by ABB Bomem of Québec City. Funding for the ACE mission, including both Canadian instruments, is provided by the Canadian Space Agency's Space Science Program.

How ACE-FTS functions

The ACE-FTS instrument is designed to simultaneously measure the temperature, trace gases, thin clouds, and aerosols found in the atmosphere using a solar occultation technique. For this technique to work, the orbiting satellite must first point to the Earth's horizon during sunrise or sunset. As the sun "moves" through the thin band of atmosphere at the horizon, its rays are partly absorbed by the various gases in the atmosphere at different altitudes. It is these gases and their distribution that the high-resolution, infrared ACE-FTS will measure. Thus, as the instrument observes the rising or setting sun, it can perform its measurements throughout the whole thickness of the atmosphere. Aerosols such as those caused by gases ejected by volcanoes will also be measured.

SCISAT-1's low orbit of 650 km above the Earth will give the ACE-FTS instrument extensive coverage with an emphasis on mid-latitude areas, such as Canada and the United States, as well as the polar region. The area to be scanned will be from about 4 km above the cloud tops (or the boundary layer for clear scenes) up to about 100 km. SCISAT-1 will orbit the Earth 15 times a day, providing 30 daily opportunities (sunrises and sunsets) to take its precise measurements.

Complements other experiments

ACE-FTS will measure the density of a large number of chemicals in order to make an accurate estimate of both chemical loss and the movement of ozone in the polar winter and springtime. Its results will be complemented by those gathered by MAESTRO. The overall ACE mission will work in conjunction with other instruments and missions planned by NASA, the European Space Agency, and other international partners over the next decade to gain a better understanding of the chemistry and dynamics of the stratosphere with an emphasis on ozone.

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SCISAT-1: The Fourier Transform Spectrometer (ACE-FTS)

MAESTRO being added to ACE mission

A second instrument, MAESTRO has been added to the Canadian Space Agency's SCISAT-1 mission. SCISAT-1 is Canada's first scientific satellite since 1971. MAESTRO, which stands for "Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation," will aid in the satellite's overall mission of increasing our understanding of the chemical processes involved in the depletion of the ozone layer. SCISAT-1, which is set for launch mid-year 2003, is already carrying the Canadian-built Fourier Transform Spectrometer (ACE-FTS) instrument as part of the overall mission, dubbed Atmospheric Chemistry Experiment (ACE).

MAESTRO is being developed, in co-operation with the Canadian Space Agency, by Toronto-based Meteorological Service of Canada, the University of Toronto, and EMS Technologies of Ottawa. Funding for the ACE mission, including both Canadian instruments, is being provided by the Canadian Space Agency's Space Science Program.

MAESTRO's goals

MAESTRO's primary scientific goal as a part of the ACE mission will be to provide high-resolution data on the atmosphere and precise profiles of ozone concentration. Other goals include measuring the amounts of organic and inorganic particles under polar ozone holes and near large tropospheric pollution sources, such as active volcanoes. The troposphere is the portion of the atmosphere that lies between the Earth's surface and an altitude of approximately 15 km. It consists of water vapour, gases, and vertical winds that account for much of our weather.

Comparing the data gathered by MAESTRO with that from the ACE-FTS instrument will help scientists determine the levels of aerosol in the atmosphere, which is crucial to understanding why and how fast the ozone layer is depleting.

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EXHIBIT 3

List of Technical Documents

Exhibit 3 – List of Technical Data

This table summarizes the information contained in the International Agreement
between NASA and the Canadian Space Agency.
Listed in this table are the only portions ANALEX, and America Intellicom, Inc. (aka AISolutions) have potential to export.

Technical Data description	**Joint Mission Implementation Plan (JMIP) Paragraph / Subsection**
Mission Integration Working Group (MIWG), Ground Operations Working Group (GOWG) and Launch Operations Working Group (LOWG) will be conducted in accordance with the Small Expendable Launch Vehicle Services II (SELVS II) . Discussion will involve the following	**4.2.2**
• Spacecraft to Launcher Interface Control Documents (ICD)	-
• Spacecraft/launch vehicle technical interface issues	-
• Technical splinters will be held as a part of the meetings on an “as required” basis	-
• Technical Interchange Meetings (TIMs) will be held as required on specific technical subjects/problems	-
• Telecons on specific topics also will be held as required	-
NASA/CSA Reviews & Launch Site Activities	**4.2.3**
• Flight Readiness Review	-
• Launch Readiness Review	-
• Launch Management Coordination Meeting	-
• Mission Dress Rehearsal	-
Payload processing, launch vehicle integration, and test	**6.3**
• Payload Requirements Document (PRD)	-
• Launch Site Support Plan (LSSP)	-
• Launch Site Test Plan	-
• Launch Site Procedures	-
• Combined System Test	-
Review/Comment on the following spacecraft deliverables	**7.1**
• P/L Launch Site Test Procedures, Final (S/C Stand Alone & Integrated S/C-L/V)	-
• Final Launch Window Constraints	-
• P/L Launch Checklist / Mission Constraints	-
• P/L Dress Rehearsal Requirements	-
Review/Comment on the following NASA deliverables	**7.1**
• Post-Launch State Vector	-
• Coupled Loads Analysis – Preliminary	-
• Coupled Loads Analysis – Final	-
• Preliminary Mission Analysis	-
• Final Mission Analysis	-
• RF link and compatibility	-
• Post Launch Quick Look Analysis	-
• FRR & LRR High Level Minutes	-

The following paragraph should also be quoted from the Joint Mission Implementation Plan, which is part of the International Agreement

4.1 Points of Contact
The SCISAT-1 PM will also interface with the KSC Launch Vehicle Project Manager on all matters relating to the launch services including launcher/payload interface, launch site, launch activities, schedule, and cost.

Neither agency shall interact with the others contractors without the prior approval of the other. Interaction between the agencies contractors is permissible in order to expedite joint technical issues as appropriate. No agreement can be reached between the contractors which has the potential to change cost, schedule or technical requirements of the payload and/or launch vehicle or violates the terms and conditions of this plan.

All correspondence and official communications shall be between the points of contact designated below or their designated appointee.

EXHIBIT 4

Technology Transfer Control Plan (TTCP)

Technology Transfer Control Plan
to accompany the
Technical Assistance Agreement
Between
Analex Corporation (U.S.) and Bristol Aerospace Limited (Canada)
for the Science Small Satellite 1 (SciSat 1)

General: This Technology Transfer Control Plan (TTCP) is intended to supply guidance and direction to employees of Analex Corporation (Analex) and its subcontractors (if any) for protecting United States technology from inadvertent and illegal transfer to foreign nationals employed by any of the parties to the subject Technical Assistance Agreement (TAA) or any other agreement concerning SciSat 1. To be effective, a TTCP must identify what technology may be transferred or co-developed through discussion, display, or by physical means such as paper, e-mail, or Internet. It must identify to whom such transfers may be made and it must prescribe means to report the transfers and any violations of the terms of the TAA. Lastly, it must provide a means to both train employees and record that training.

Background: The National Aeronautics and Space Administration (NASA) has negotiated a formal Memorandum of Understanding or MOU with the Canadian Space Agency that has the former agree to use its launch services contract to launch the Canadian-built SciSat 1; to support its operations once on orbit, checked out, and functioning; and to share the Earth science data that SciSat 1 will produce. The MOU calls for the signatories' centers and contractors to produce a detailed breakout of the tasks and responsibilities of the parties called a Joint Mission Implementation Plan or JMIP that shall be empowered by the MOU and have the force of an international agreement.

The Canadian Space Agency has contracted with Bristol Aerospace Limited, the SciSat 1 prime contractor, for the spacecraft and Bristol is integrating sensors and Canadian components for the Atmospheric Chemistry Experiment (ACE) sensors, a Fourier Transform Spectrometer (ACE-FTS) and MAESTRO, which stands for "Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation;" communications; spacecraft orientation, navigation, and control systems; and on-board logistics and components.

NASA has contracted with Analex to provide the on-site payload-to-launch vehicle integration services under the ELVIS contract with NASA's Kennedy Space Center (which operates NASA's facilities at Vandenberg AFB, California.) Analex' role will be to provide on-site technical, security, and administrative support to launch services personnel and to assist in the technical preparation of the spacecraft at Vandenberg.

Analex personnel will perform the work on site at Vandenberg AFB, California to get the launch vehicle and SciSat 1 payload integrated and ready for launch, and will then assist with on-orbit checkout and other tasks required of it by the JMIP and the ELVIS contract Statement of Work or SOW.

What may be Transferred: The TAA authorizes Analex to carry out the tasks described in the JMIP and the ELVIS SOW and to permit Bristol's employees to have access to the technical

documents described in the TAA. Thus, ANNEXES B and C and Exhibit 2 of the TAA, as allowed in the final State Department license; i.e., the TAA in the form and with the provisos returned to Analex by the Office of Defense Trade Controls, describe the techniques, know-how, and technical data that are permitted to be shared.

Training: All Analex employees working on SciSat 1 are required to have completed Kennedy Space Center (KSC) web based training lessons: "Basic Export Control Program," "Foreign National Visit Processing," and Technical Information Exchange." These lessons are provided in CD-ROM format for those who do not have access to the internal KSC website. All Analex employees working on SciSat 1 will read the JMIP and the ELVIS SOW. These establish the procedures they are to follow and the limits to their cooperative work with Bristol employees.

All training will be recorded by the Analex Program Manager (PM.)

Operations: From the first moment that Analex and Bristol personnel start work until the final moment of such cooperation, Analex personnel will observe the limits to cooperation that the TAA permits. Logs or other records of topics discussed, documents accessed, issues resolved, and other cooperative work will be kept up to date and will be accessible to employees, managers, and NASA alike. Where the topics discussed and the work done are clearly within the framework of the TAA, these records need not be elaborate or detailed. Where there is any question of whether or not the material worked with falls within the bounds of the TAA, then detailed records of what was discussed, with whom, when, and where must be made. Such records must also be available as before, but it is the responsibility of the senior employee involved to make the Analex PM aware of the matter as soon as possible. If at any time any Analex employee is uneasy about what is being done or discussed, it is perfectly appropriate for the employee to terminate the activity at once and report it to the Analex PM or such person as the Analex PM has designated to receive these reports.

Physical security will be provided by NASA and Analex in accordance with the procedures specified by the Commander, 30th Space Wing, USAF. These procedures are stringent and call for 100% escort for all foreign nationals while on Vandenberg AFB. Compliance with these procedures supports this TTCP.

NASA has published its direction, procedures, and guidelines in NASA Program Directive (NPD) 1371.5, Coordination and Authorization of Access by Foreign Nationals and Foreign Representatives to NASA and NASA Program Guidance 1371.2, Coordination and Authorization of Access by Foreign Nationals and Foreign Representatives to NASA, use of which is mandated by the ELVIS contract. NASA has also implemented an automated visit control system, the NASA Foreign National Management System (NFNMS). NASA's processes for handling foreign nationals call for checks of various U.S. Government agency lists to determine if individuals have been listed as barred from doing business with the Government or are otherwise to be carefully watched. NASA visit processes will be used to manage visits by Bristol personnel to Vandenberg and to meetings, etc., held on the subject of SciSat 1. Compliance with these procedures supports this TTCP.

KSC Procedures for foreign national access to KSC and CCAFS are contained in Kennedy Handbook (KHB) 1610.1, KSC Security Handbook, Section 406. These call for a Technology Transfer Risk Assessment (TTRA) for visitors from certain countries and for any visitor who will be on station more than a total of 30 days in one year. This procedure is specifically extended for Bristol personnel working at Vandenberg for more than 30 days in one year. Compliance with these procedures supports this TTCP.

Recording: All records, logs, notes, etc., that result from the operation of this TTCP will be maintained under the control of Analex' Empowered Official for five (5) full years after the end of the project.